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THE

SCIENTIFIC PROCEEDINGS

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ROYAL DUBLIN SOCIETY.

ON GREAT TELESCOPES OF THE FUTURE.

BY

HOWARD GRUBB, F.R.A.S.,

Honorary Master of Engineering, University of Dublin.

Abstract.

[The full Paper read February 19th, 1877.]

In this paper the author discusses at length the advantages and disadvantages of the various forms of telescopes; how and to what extent these advantages and disadvantages would be modified by any great advance in size over these telescopes at present in existence; the practical difficulties of construction of said instruments, and the most promising manner of overcoming these difficulties.

In discussing the advantages of the refractor over the reflector the author shows, as regards the greater brilliancy per unit of surface of the refractor that this advantage lessens by increase of size, and that a size must shortly be reached in which this advantage will vanish altogether; while as regards the greater permanence of collimation, preservation of optical parts in good working order, and general suitability for ordinary observing work, the author shows that monster telescopes of the future, when erected, will in all probability be devoted to special work which could not be done with smaller instruments; and that most of these advantages diminish in value with increase of size of instrument, whereas some of the advantages claimed for reflectors

over refractors become of greater value for the larger sized instruments. Among these the author makes mention of "absence of secondary spectrum," "possibility of equable support," and "general convenience for observing purposes."

At the same time the author shows that there are many interesting physical problems to be solved for which it will be absolutely necessary to use reflectors of large size.

The author then discusses the practical difficulties of construction of each type of telescope, and the most promising means of overcoming these difficulties.

The author argues that the practical limit to the increase of size of refractors is that of procuring suitable discs of glass.

They have never yet been obtained over twenty-nine inches in diameter, and it is probable that in the present state of the art it would not be possible to procure them of many inches over that size.

Supposing, however, that large discs were obtainable, a question arises whether the edge support, which is alone admissible in a refractor would not cause such a strain as would injure the performance of the objective, either by distortion of image or temporary polarization of the light.

To obviate this, should it be found necessary, the author has devised an apparatus by which each disc of glass is partially supported on an air cushion; air being forced into the telescope tube, and regulated in pressure by an automatic contrivance according to the altitude *pro tempore* of the telescope, (the lower end of the tube is supposed to be closed by a small lens equivalent to a low power Barlow.)

Silver on glass mirrors the author places out of the discussion altogether as in the present state of the art of glass making it is not found possible to obtain discs over six feet in diameter.

The great difficulty in the preparation of metallic reflectors is in the successful cooling of the disc, and to obviate this difficulty the author has devised a peculiar kind of annealing oven which he describes at length.

With this oven it is possible (without of course opening it in anyway) in the first place to ascertain exactly the relative heat of different parts of the disc of metal, and 2ndly to modify the heat of the different parts according to desire.

With this oven the author considers that it would be possible to anneal discs of very large size.

The general conclusions arrived at by the author are, "That no one kind of telescope is the best possible for all kinds of work," and in choosing the best form of telescope reference must be had to the uses for which the telescope is intended, its position, surroundings, &c.

The author speaks also of experiments that are being made, which, if successful, will increase the reflective power of metallic mirrors by 25%, and add considerably to the balance of their advantages.

In discussing the most suitable mounting for such monster instruments the author suggests that all the laborious operations connected with the working of the equatorial should be effected by hydraulic power, so as to relieve the observer from any excess of manual labour or dependence on subordinates.

SHORT REPORTS FROM THE CHEMICAL LABORATORY OF TRINITY COLLEGE, DUBLIN.

BY

J. EMERSON REYNOLDS, M.D.,

Professor of Chemistry, University of Dublin.

No. IV.

On a New Form of Measuring Apparatus for a Laboratory Spectroscope.

[Read February 19th, 1877.]

THE measuring apparatus for a laboratory spectroscope which I have been asked to describe, was fitted about a year ago to an instrument in common use in the College Laboratory, and has afforded very satisfactory results. My chief aim in planning the arrangement, was to facilitate the measurement and identification of spectral lines and the mapping of spectra under circumstances admitting of little general illumination.

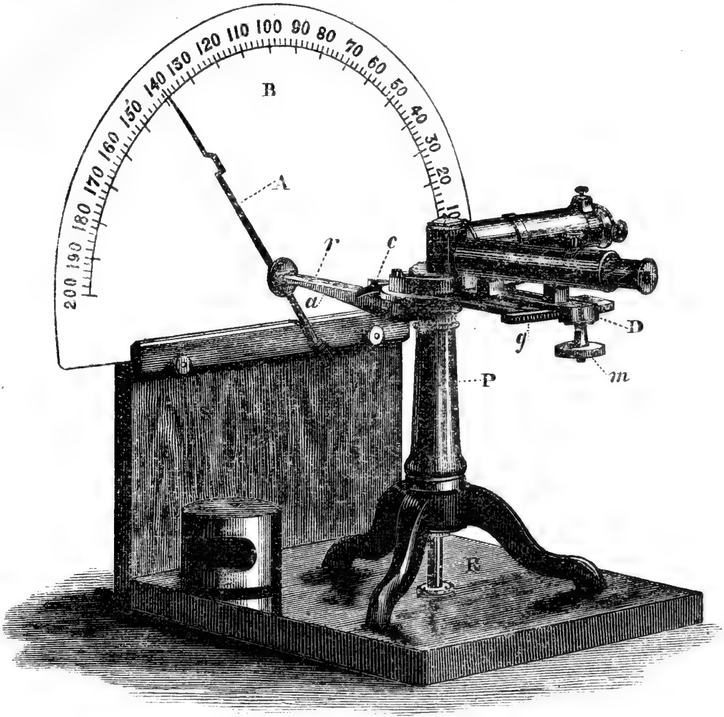
The spectroscope to which the apparatus is fitted has two fixed flint glass prisms, the refracting angle of each being 60°. This instrument is shown in the annexed engraving. When in use the prisms are covered by a brass cap provided with openings for the collimating and observing telescopes. The movable arm D that supports the observing telescope also carries a vernier which is moved with the telescope over a graduated arc, and in this usual way the relative positions of the several lines of a given spectrum can be determined. The angular distance traversed in passing from the extreme red to extreme violet is necessarily small owing to the low dispersive power of the instrument; but this, I need scarcely say, is an advantage rather than the reverse in a spectroscope which is commonly employed as an aid in ordinary qualitative analysis.

For Report No. I., "On Glucinum; its Atomic Weight and Specific Heat," see *Philosophical Magazine* [5], vol. iii., p. 38; for No. II., "On a New Mineral Borate," and for No. III., "On an Analysis of Lievrite, by Mr. Early's Method," see *Phil. Mag.* [5], vol. iii., pp. 284 and 287.

The graduations of the arc are unavoidably close and difficult to read in a feeble light; consequently the eyes of the observer become speedily tired and unfitted for the examination of faint spectra. Nevertheless measurements made with the graduated arc and vernier are, in my experience, more trustworthy and satisfactory than those obtained with even the best photographed scale that I have had the opportunity of working with. Desiring, then, to retain the method of direct angular measurement I sought to multiply the motion in such a manner as to obtain wide readings on a convenient scale. After many trials in different directions the form of apparatus which I shall now describe was finally adopted.

Description of the apparatus.—The annexed woodcut, which is taken from a photograph, represents the whole apparatus. The index A attached to the spectroscope, moves in front of a graduated plate of opal glass, the latter being supported in the manner shown by the stand S,* to which the spectroscope is also screwed by means of the rod R. The index is attached to a milled head which moves stiffly on a stout steel rod *r*; the latter can revolve in little bearings supported by the projecting arm of "angle brass" *a*, the other end of the rod being let into a hole drilled in the head of the pillar, P, of the instrument. On the rod just mentioned, and immediately beneath *c*, a small toothed wheel is securely keyed. The diameter of this wheel is about one centimetre and the teeth upon it are fine and well cut. *c*, is a stout metallic strip, five centimetres long, whose lower edge is serrated so as to correspond accurately with the teeth of the wheel on the rod *r*, and to act upon the teeth directly so as to cause the rod carrying the index, A, to rotate easily. This strip is bent to a curve whose radius is equal to the distance from the axis of the pillar, P, of the instrument to the middle of the toothed wheel. The strip is attached to a stout arm and this is in turn screwed to the slightly projecting end of the heavy plate, D, which carries, and of course moves with, the observing telescope, the motion being communicated to the latter by turning

* The stand is of stout walnut wood. A rebate of the thickness of the glass plate is cut to the depth of three centimetres from the vertical piece of the stand. The straight edge of the plate is laid in the groove and is there secured, in part by a pin passing from behind through a hole drilled in the glass, and in part by a wooden slip screwed on in front.



the milled head m. As the observing telescope moves over the graduated arc g, the index A moves in front of the graduated plate B, but in the opposite direction, for the motion of D, is communicated to the rod r by means of the serrated slip c. When the fittings are well made, the movement of the index A, is steady and corresponds in both directions with those of D. By the simple means described, a very slight motion of the observing telescope produces a comparatively considerable displacement of the index A.

In my instrument, the telescope and the index move in opposite directions. Any objection on this score can be removed, for it is only necessary to point out that the motions may be made to coincide in direction by placing c under instead of over the toothed wheel.

Graduation of the glass plate.—It is very desirable that the graduations on the plate and on the arc of the instrument should agree; the best mode of securing this is to graduate the plate

with the aid of the arc. For this purpose the telescope is moved into such a position that the rays less refrangible than the red Potassium line shall occupy the field of view; the zero of the vernier is then made to coincide with the nearest convenient degree marked on the arc. The rod r is then firmly grasped and the index A brought down to a horizontal position, and a fine dot made on the plate under the point by means of a pen dipped in "black japan." This point is taken as the zero of the scale. Each half degree is marked off in a similar manner until the semicircle is graduated. The two scales are again compared at different points, and the opal glass plate removed; each large division, corresponding to half a degree, is then subdivided into 10* equal parts. Finally, the semicircle is numbered from zero up to 200; each division of the scale therefore corresponds to 3′ of the arc g. In my spectroscope the angular motion of the observing telescope is magnified 25 times, and the width of each division of the glass scale is $2\frac{1}{2}$ millimetres, so that the readings are easily made in a feeble light without straining the eyes of the observer.

Reading off positions of spectral lines.—In commencing an observation it is always desirable to see that the point of the index A stands at the zero of the glass scale when the telescope is in the corresponding position on its scale. Any adjustment of the index that may be necessary is easily made in the way already described, namely, by firmly holding the rod r and turning the milled head which carries the index to the desired extent. The actual reading of the position of a line to which the point of the fine needle in the eye-piece is brought is then made from the glass scale.

An exceedingly feeble light suffices to enable the operator to read the wide divisions on the white scale; but in observing very faint lines I do not read by reflected light, but faintly illuminate the scale by means of a very small gas jet or lamp placed *behind* it. Sufficient light is transmitted by the opal glass to enable the readings to be easily and quickly made, while the eye of the operator is retained in a sensitive condition for feeble rays. Moreover, in reading it is not necessary to move the head away from the eye-piece of the instrument.

* In the woodcut only five subdivisions are shown.

I have tried with success a mode of determining small differences with this apparatus which could doubtless be applied with advantage in mapping spectra with instruments of high dispersive power.

The glass plate B was removed from its stand and the index from the rod *r;* I then attached to the latter a cork carrying a small mirror placed at a suitable angle. A spot of light was reflected from this mirror and made to fall on a screen placed several metres away. The relative distances between the members of groups of closely ruled lines (those of the Nitrogen Spectrum) were then easily determined in this manner, as the actual motion of the needle from point to point was greatly magnified.

The relative positions and widths of the lines seen with the instrument are easily laid down on a millimetric scale. I have had a number of 200 m.m. scales printed on narrow slips of paper; and the graduations are lithographed on a band of six equidistant lines which thus serve for marking off intensities, according to Bunsen's graphic method. One millimetre corresponds to one unit of the scale on the opal glass screen, and consequently to three minutes as read off with the vernier on the graduted arc of the instrument. Differences corresponding to 1′ can therefore be easily estimated and represented on the millimetric scale.

But one other practical point need be mentioned. I find it exceedingly convenient to mark off on the opal glass scale the positions of the more important lines of the elements whose spectra are easily obtained with the aid of the Bunsen flame. The symbol of the element to which a particular line or band belongs is legibly written under the particular point of the scale, and connected by a line with the point in question. Identification of the bright lines observed in the spectrum of an unknown compound is thus greatly facilitated.

I may be permitted to add that the measuring apparatus described has been fitted to the spectroscope used in the College Laboratory by Messrs. Yeates and Son of this city, whom I have to thank for the care and skill with which they carried out the details of construction.

ON THE ORIGIN OF "THE SCALP,"

A REMARKABLE CLEFT IN THE GRANITE HILLS SOUTH OF DUBLIN.

BY

EDWARD HULL, M.A., F.R.S.

Director of the Geological Survey of Ireland.

[Read March 19th, 1877.]

ONE of the most peculiar natural features of the neighbourhood of Dublin is the deep cleft, known as "The Scalp," by which the traveller is introduced into the mountainous district of Dublin and Wicklow, from the plain to the northward. This cleft traverses transversely a low spur of the ridge of granitic and schistose rocks which stretches from the coast of Killiney, by the Three Rock Mountain, Glendoo Mountain, and the ridge dividing the sources of the Glencree and Dodder Rivers, to Kippure, at an elevation of 2,475 feet.* It is in fact a ravine of about 325 feet in depth, and at an elevation above the sea of about 500 feet along its bottom, bounded by steep, sometimes precipitous, banks of granite towards the north, and schist at the southern extremity. In this direction the schist is admirably exhibited in the western face of the hill resting on the granite; and the boundary between the two rocks passes across the valley without any break or displacement of the beds, which dip S.S.E. at about 50°.

The ridge which is intersected by "The Scalp" forms the watershed between the streams which flow into the Shanganagh River on the north, and those which pass into the Dargle or Bray River on the south, so that there is scarcely any stream in the ravine itself. The actual watershed as you pass along the road which traverses "The Scalp" is reached about 200 yards north

* The actual watershed runs along a low ridge about 200 yards to the north of the entrance to "The Scalp" where the road crosses it. A small streamlet, of about a foot across, comes down the intervening hollow between the main ridge and the lower one already referred to, from the west, and unites with another streamlet which issues forth from a pond situated in a field close to the road. The little brook thus formed, runs down through the Scalp, and when visited at the end of March, 1877, and after a wet season, was only two feet wide and four inches deep on an average throughout a distance of 100 yards.

of the entrance to the ravine near the School-house; and yet no one who is conversant with the forms of river valleys can doubt that "The Scalp" has been formed by river action, and that a considerable stream, somewhat proportionate to the size and depth of the ravine, originally flowed through it.

In the following observations, therefore, I must assume that the Scalp is the channel of a river which once flowed through it, and that it has been scooped out by river action. If anyone denies this, I ask him to explain its formation by any other hypothesis consistent with observed physical facts. The Scalp is certainly not due to a "gaping fissure" in the rocks, or to a fault or a fracture, as the schists pass across from side to side with perfect regularity, as shown by the Geological Survey Map (Sheet 121); besides, geologists are agreed that it is altogether unphilosophical to call in the hypothesis of gaping fissures in order to explain such features as that here referred to.

I assume then that the Scalp is an old river-valley, and the question arises;—What has become of the river which once rolled through it? for assuredly the little driblet of a foot or two in width which runs by the road-side cannot be considered as the sculpturing agent in this work, if we suppose that there is any proportion between the work done and the agent—between the river-valley and the river which has made it.

The answer to the above question, as it appears to me, is to be sought in the restoration of the original stratification of the country. From several considerations we have reason to believe, that the granitic and schistose rocks of the Dublin and Wicklow range formed a ridge in the sea in which the Carboniferous strata were deposited. Fragments of granite have been found imbedded in the limestone itself in the neighbourhood of Dublin, proving that the granitic ridge was in existence, probably rising in places from beneath the Carboniferous sea with a shelving shore, which sea itself stretched far way northwards and westwards. The Upper and Middle Carboniferous strata were originally deposited wherever the limestone itself was formed, so that the great central plain of Ireland was in all probability the seat of a wide-spread coal-formation, which has since been swept away by denudation with the exception of a few little patches, such as those of the Kilkenny and Slieveardagh coal-fields, which have

been preserved to us as relics, or monuments, of more extensive tracts. Such patches are like the solitary columns, or noble gateways of the ancient cities of the world, the original extent of which is to be traced by the foundations of the walls, or buildings, which spread widely around the still upright monuments. Taking the series of strata as it occurs in the Kilkenny coal-district, we find that the thickness of strata originally superimposed upon the Carboniferous limestone of the central plain of Ireland, was at least nearly 2,000 feet as indicated by the following table:—

Carboniferous series of Kilkenny and Carlow.

			Thickness. Feet.
g. Upper and middle coal-measures, incomplete, in part denuded away,			390
f. Lower coal-measures (with thin coals),			400
e. Flagstone series,			650
d. Shale series ("Yoredale beds"),			500
			1,940
Carboniferous Limestone *	*c.* Upper,	550	
	b. Middle,	600	1,850
	a. Lower,	700	
			3,790

Now, of the above series, all the beds from *c* to *g* inclusive, have been stript by denuding agencies from off the surface of the country lying at the base of the Dublin and Wicklow range of mountains, and having a combined thickness of about 2,490 feet.†

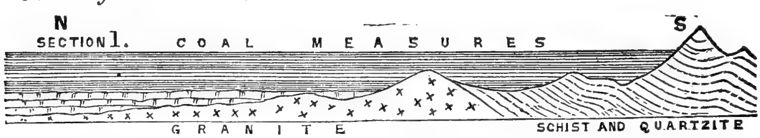
If we restore the strata as they existed at the close of the Carboniferous period we shall have to pile up this 2,490 feet in thickness, of limestones, soft shales, flagstones and sandstones, beds of coal; all friable, more or less loosely compacted and easily destructible strata, and then it will be found that (allowing also some amount of denudation for the harder granites and schists of the mountains) the ground to the north will have been relatively higher than that now forming the ridge of Killiney and Shankill. Thus, on the elevation of the whole country into a land-surface at the close of the Carboniferous Period, and assuming a slight slope

* "Explanation" of Sheet 137 of the Geological Survey Maps, p. 10.

† The middle limestone (*b*) forms the floor of the Dublin district.

of the surface southwards, it is easy to conceive that a stream might have commenced to run along a channel in the coal-measures, directly over the line now occupied by "The Scalp." There would thus be a high sloping plane of Carboniferous strata lying to the north of the Dublin mountains, and forming gathering ground for a stream which took its course along the tract now occupied by "The Scalp" towards the sea, very much in the direction where the river Vartry enters the sea at the present day. If we restore the original strata in the manner here indicated we shall find that the Carboniferous beds must have completely enveloped all the granitic region of a lesser elevation than Kippure, Lugnaquilla, and some of other high eminences; even after making allowance for a considerable amount of denudation from off these eminences themselves.

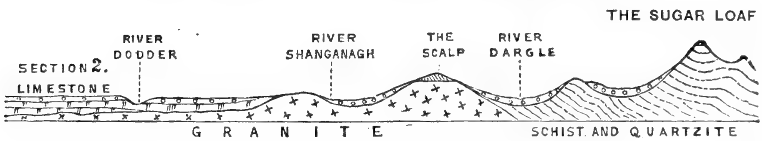
Fig. 1.—*Geological section through the Central Plain, and Wicklow Mountains, restoring the original Stratification as at the close of the Carboniferous Period.*



I conclude, then, that a stream flowed southwards and eastwards, from a higher plain lying where the lower plain of county Dublin is at present, and passing over the ground now occupied by the Scalp, and the depression extending to the Vartry valley, eastwards towards the sea, which was probably much further off than at present. The period through which the land was now exposed to denudation was immensely extended, ranging downwards through the Mesozoic into Tertiary times; and throughout this enormous lapse of time the central plain of Ireland was being denuded of its coal-formation, and, to a large extent also, of the Lower Carboniferous rocks which underwent chemical dissolution from waters charged with carbonic acid. During this time the whole country would be exposed to denudation—river channels would be formed in the Carboniferous beds, and (when these were removed) in the underlying granitic and schistose rocks. It was at this stage that I consider "The Scalp" to have been cut out of the granitic and Silurian schists; and the question next arises—

why has the river itself disappeared? The answer to this question is not difficult; nay, is almost obvious. During the progress of denudation some districts would be more rapidly stript of their rocks and strata than others. The loose beds of shale, flagstone, sandstone, coal, &c., of the Carboniferous area would be disintegrated and carried away by the rains and rivers much more rapidly than the solid granite, tough schists, and quartzites; all highly tilted, and therefore, more suited by position to resist weathering than the nearly horizontal beds of the Carboniferous system. Thus, then, while all rocks exposed to the atmosphere were subjected to waste, those of the Carboniferous area were carried away more rapidly than those of the country to the southwards. In other words, the Carboniferous plain became relatively lowered more rapidly than the granitic area to the south, and ultimately so much so, that the granite and Silurian ridge became the watershed; and the stream, which had up to this time flowed through "The Scalp," was diverted from its course, and began to run down towards the position of the existing valley of Shanganagh River.*

Fig. 2.—Geological section through the Central Plain, and Wicklow Mountains, showing existing Stratification.



It is, in fact, exceedingly probable that the stream now called "The Shanganagh" River originally flowed through the Scalp, and that its present course and direction is due to the change in the relative levels of the granite hills and the limestone plain. The vicissitudes of the granitic mountains are themselves remarkable. Originally upreared and developed, probably at the same time as the mountains of Donegal, Mayo, and Galway, viz., at the close of the Lower Silurian period, they were again nearly buried (as we may say) under Carboniferous strata, but were

* Suppose, for example, that the granitic and schistose area was denuded at the rate of one-tenth of an inch in 1,000 years, and that of the Carboniferous at the rate of one inch in the same period, it is evident that the Carboniferous and granitic areas would ultimately assume the relative positions they now occupy.

afterwards unmasked, and redeveloped, by the stripping off of these strata during the Mesozoic period. At a much later period they were partially submerged under the waters of the glacial sea, but never again buried under more recent strata; as there is no reason for supposing that the Mesozoic formations were spread over this part of Ireland.

It may be asked, however, "Why have you assumed that the original river flowed from the north through the gorge of 'The Scalp,' rather than from the south?" This would be a very natural question, and one the reply to which is not very obvious. Still, whatever evidence exists is in favour of the view here indicated, namely, that the original stream flowed from the north. It will be observed that the little stream which now rises just to the north of "The Scalp" itself flows *southward* through this channel, and consequently that the slope of the bed of the ravine is in a southerly direction. This, I submit, affords a clue to the original direction of the old river; because it is extremely improbable that the slope of the original river-bed would become reversed from any cause. All the chances are in favour of the original slope being retained; and I have therefore adopted the evidence afforded by the direction of the existing slope as that upon which to found an opinion regarding the direction in which the original stream may be considered to have flowed.

On the lowering of the ground to the north of "The Scalp" to a level below that of this old river-bed, the stream would naturally take a course along the northern flank of the Shankill ridge, eastwards towards the sea; and as successive beds of the Carboniferous formation were stript off, the stream would work its way more and more northward, until ultimately it has attained the position of the Shanganagh brook of the present day.

Before concluding it is right that I should state that a former President of the Geological Society of Dublin, Dr. Scouler,* has given it as his opinion that "The Scalp" was formed subsequently to the Drift, or Glacial Period, on the ground that no vestiges of drift deposits are to be found in the valley of "The Scalp" itself; but even if it were the case, that no drift beds are to be found in the valley, it by no means follows that "The Scalp" was hollowed

* Anniversary Address. Jour. Geol. Soc., Dub., Vol. I.

out after the Drift Period. The presence or absence of Drift deposits is due to a variety of causes, all of which must be determined before we can draw any conclusions therefrom. In the case of the ridge traversed by "The Scalp," the Drift deposits are absent generally from all the ground above a level of about 400 to 500 feet, having either not been deposited above this level, or if otherwise, having subsequently been denuded away. The bottom of "The Scalp" dell is 500 feet above the sea, and just beyond the usual limit of the Drift deposits thereabouts, as shown on the maps of the Geological Survey. As a matter of fact, however, I am assured by the Rev. M. Close, F.G.S., who has so carefully examined the Drift deposits of this district, that he has noticed some traces of these beds on the floor of "The Scalp" dell itself; so that its greater antiquity than the Drift, or Glacial Period, is thereby proved.

PRELIMINARY NOTE ON SOME MEASUREMENTS OF THE POLARIZATION OF THE LIGHT COMING FROM THE MOON AND FROM THE PLANET VENUS.

BY

THE EARL OF ROSSE, F.R.S.

[Read and handed in, Monday, May 21, 1877.]

SEVERAL years ago, at the suggestion of a friend, having examined some portions of the lunar surface with a Nicol's prism with a view to the detection of small sheets of standing water, if any such chanced to exist, I was led on to make a rather extended examination of particular portions of the surface with the polarimeter, under the idea that if the precise position of elongation from the sun where the polarization of a point of the lunar surface attains a maximum could be accurately determined, it might be possible to obtain an approximate value of the refractive index of the material composing that surface, and so to distinguish between material of a vitreous nature, ejected from volcanoes, and a surface of ice and snow.

The subject has been invested with the greater interest from the fact that Arago, having found the maximum of polarization of the whole of the moon's light to occur at, or near quadrature, remarks on the circumstance as being what might be expected to result from the reflecting surface being gaseous; and he appears to think that the polarimeter may afford us some information on the question of the existence of a lunar atmosphere.*

During the years 1872–3–4–5 we have at intervals made a rather extended series of measurements with the polarimeter, of which several different forms were tried, but one differing in little from Arago's, was found the more satisfactory.

Although from a series of sixteen readings of the inclination of the plates of parallel glass, a value may be obtained for the polarization on each night with a probable error of observation not exceeding one per cent., from some cause not yet established, the discrepancies between the various nights' work are much larger, and the results must be accepted with reserve and considered as only provisional.

* Arago: Œuvres, nouv. ed. par Barral, liv. xiv., chap. vi., t. ii., p. 101, &c.

The most probable values for the polarization (P), meaning by that term, the proportion between the intensities of the components of the light polarized in and perpendicular to the plane passing through the sun at the several elongations (E) are for Mare Crisium—

E =	P = 1 ÷	E =	P = 1 ÷
60°	0·830	110°	0·840
70	0·815	120	0·890
80	0·795	130	0·930
90	0·785	140	0·965
100	0·805	150	0·980

Similar, but less numerous measures than those on which the above table is based, were made for Mare Imbrium, Mare Serenitatis, Palus Somnii, and the region between Macrobius and Proclus and other parts. The polarization varies with the situation, and with the nature of the surface, being in general greater on the plains than on the more uneven parts.

Measurements of the light of the planet Venus made between 1872, March 12th and April 6th, gave a mean value for the polarization of 0·925, of which no regular variation was perceived during the progress of the observations, although the change of phase which occurred during the interval was considerable.

May 15th, 1877.

NOTES ON THE IRISH CRUSTACEA.

BY

WILLIAM ANDREWS, Esq.

FIRST SERIES.

[Read May 21st, 1877.]

SINCE the death of my lamented friend and esteemed colleague in science, Dr. John Robert Kinahan, F.L.S., Honorary Secretary to the Natural History Society of Dublin, no attempts have been made, scientifically, to investigate the crustacea of Ireland, in addition to those lists which he had so carefully reviewed and revised. Few possessed the same zeal and energy, whether as a practical investigator, or a sound inquirer into the views of theoretic science; therefore, the loss is to be deplored of him who promised, as a faithful expositor, to be one of our brightest labourers in the field of natural science. Irish authorities previous to the period of his published investigations, were numerous, amongst whom may be enumerated Doctors Robert Ball, and Drummond, Forbes, William Thompson, Allman, Paterson, Hyndman, Melville, and an ethusiastic collector, William M'Calla. These have all more or less contributed to the knowledge of that branch of Natural History.

The very valuable observations of Captain Du Kane, and of J. V. Thompson of Cork, in metamorphic carcinology, must not be forgotten, the foundation established of insight into the early stages of metamorphic development. The persevering zeal of the late William Thompson of Belfast, and the candour with which all his communications were carried out, when, alas, rivalry and jealousy too generally existed, cannot but be most pleasingly held in recollection. His papers contributed to the Annals of Natural History in the volumes for the years 1842 and 1843, have fully noticed the Irish crustacea known at those dates, and which have been continued in the fourth volume of the work on the Natural History of Ireland, published in 1856.

My object is to give a series of remarks on the crustacea of Ireland, and to add comments on the species which have been obtained, and as far as practicable on their habits, since the notices that have already appeared through the investigations of those

whose names I have mentioned. The collections of J. V. Thompson, of Cork,* neither, I regret to say, are those of Dr. Kinahan, myself, and others, now to be seen in the collections of the Natural History Society of Dublin, though the reports of that society show in detail, that nearly a perfect collection of *Decapoda* were carefully arranged, numbering fifty-eight species (one hundred and nine specimens), besides of genera and species of other orders, nor indeed, have authenticated specimens been preserved in our museums, illustrative as records of discoveries that had been made of several species of Irish crustacea; hence it must appear desirable that so interesting a branch of our marine zoology should meet attention to place it in a proper position, and to add any additional information of species not hitherto described in our marine fauna. It is not necessary, neither is it the intention, to enter into details of structural formation, nor of the science of component parts, but merely to notice some characteristics which may have led to, or confused specific distinctions.

In the present paper I shall confine myself to the First Order —*Decapoda,* which comprises the sub-orders *Brachyura, Anamoura,* and *Macroura.* Treating on the first sub-order, *Brachyura,* in which the abdomen is slightly developed, and of no force or assistance in swimming—generally much wider in the females than in the males—the remarks as far as necessary will be on the several genera and species, known on the Irish coasts.

Family First, *Macrapodiadœ,* Dr. Milne Edwards characterized by the extreme length of their slender legs. The first of the genera is *Stenorhynchus,* of which only one species is in the lists of Irish crustacea.

S. phalangium.—Though another is described as British *S. tenuirostris,* the separation from the former is made upon such slight variations, that I must fully concur in the views of the late William Thompson, who carefully compared those obtained by him in Ireland, with the specimens described by Leach and Bell, in the British Museum. The two presumed species presented varied differences of spinous processes, and as Thompson further remarks, "that in one of the two Irish examples of what I have called *S.*

* Purchased by the Royal College of Surgeons, and subsequently presented by the College to the Royal Dublin Society, were not, at the time they were given over to the Society, complete.

Also the collections of William M'Calla, obtained by Dr. Scouler for the Society, are not to some extent forthcoming.

tenuirostris, taken to the British Museum, the wrist has the form attributed to that species, and in the other, that attributed to *S. phalangium*." I advance those points as in remarks on other genera. I may have grounds for more strongly objecting to specific distinctions, made upon equally slender foundations.

S. phalangium is more robust, and larger than the described *S. tenuirostris*, and more frequently found in the weedy grounds of harbours and estuaries, while the other is more generally met, in clearer ground and deeper water. The former is very abundant in Dingle and Valentia harbours, the latter off the islands, and in the deeper water of the bay. Found in clear ground *S. tenuirostris*, is often of a beautiful pink or rose colour. Couch mentions having obtained it in twenty fathoms on the Cornish coast, but that he had never met *S. phalangium*.

The genus *Achæus*, of which but one species is known, was first found by J. Cranch, in Falmouth Bay, and named Cranchii by Dr. Leach, after that distinguished collector, who perished in the Congo expedition. Nothing at present can be admitted of its claims as Irish, no authenticated specimen existing in any Museum in this country, at least that can be decided as such. In the list of crustacea of the Royal Dublin Society, published in the Journal, July, 1856, *achæus* is mentioned, but no specimen is in the Museum. Dr. Kinahan stated in proceedings of the Natural History Society, April, 1857, "that a single specimen was obtained in Antrim, 1850; the only previous record of it as Irish, was a specimen formerly in the collection of J. V. Thompson, but some years past lost." It is difficult to agree to the certainty of species when no means of examination exist. In deep water among broken shells and weeds in the Blasket sound, I obtained several specimens of a crustacea which might have been considered near to *achæus*, particularly in the outline of the carapace, and the falcate or sickle-like form of the tarsi. The tubercles on the carapace are similar to *achæus*, but there are other outlines that show affinities both to Pisa, and to *Hyas*, especially to the latter in the contraction immediately behind the post orbitar process. The anterior portion of the carapace is much broader in Hyas than in the specimens that I had obtained, and the first pair of legs are considerably longer in *Hyas*. However, no identity with *achæus* can be confirmed.

Genus *Inachus*, of the three species *dorhynchus*, is the most rare of those alluded to by Thompson in his list of Irish crustacea, as he does not appear to have collected it. In the papers read before the Natural History Society of Dublin by Professor Kinahan, both species are mentioned as common on the Dublin and Galway coasts, and in Belfast Bay. *Inachus leptochirus* is not given in any of Kinahan's lists, neither have I met with it on the south-west coast, though the other two are frequent. A beautiful specimen of *Machus dorhynchus*, I have taken in deep water, of a light yellow, the carapace and fore-legs spotted with a dark sponge. William Thompson mentions *I. leptochirus* to have been dredged in Clifden Bay, Connemara. Both species, dorsettensis and *dorhynchus*, inhabit deep water, and both, according to the soundings, are found marked and coated with fungoid colorations, and small fuci, and zoophytes. In the examinations of numerous specimens scarcely any appreciable differences can be sustained. In *dorhynchus*, the margins of the shell being destitute of tubercles, and the hands smooth, would seem the only distinctive separations from *dorsettensis*, characters in the crustacea, by no means tenable.

Pisa (four horned spider crab) the next genus, species are described as presenting variations of form and structure, separating *tetraodon* from that of *Gibsii*, still there are such apparent connexions, that there are difficulties in sustaining characters which are not more or less common to both. The females are more closely allied in the defined form of the rostrum, the less spinous state of the lateral margins of the carapace, and the smaller proportions of the fore-legs. The spine described on each brancial region in *Gibsii*, cannot maintain decided distinction, as shown in the genus *Gonoplax*. Both species are subject to the growth of alga, and zoophytes covering the carapace and legs, more so in *Gibsii*, from the dense villous coat of the carapace favouring attachment. The specimen submitted is more characteristic of *Gibsii* than of *tetraodon*, and may be considered as the *arctopsis lanata* of Lamouroux—Pisa Gibsii of Leach. It was obtained in twenty-five fathoms off Innisnabroe Island, coast of Kerry, and now first presented as Irish. The only specimens in the Museums of Dublin were obtained at Roundstone, Connemara, first discovered by the late William M'Calla, the species being *tetraodon*. William

Thompson did not meet it; and in observations of Professor Kinahan on the marine fauna of the coast of Clare (Dublin Natural History Society, 1st June, 1861), he states *Pisa tetraodon* had not been recorded as occurring south of Galway Bay until he had met it in Clare. It was always in one habitat, the branching stems of that pretty alga *Gelidium corneum,* in shallow rock pools. All the specimens were young, and described as under an inch in length.

Genus *Hyas*, both species, *Araneus* and *Coarctatus*, have been taken in deep water, Dingle Bay, frequently on the trawling grounds. *Araneus* is of much larger size, and has no contraction behind the post orbitar, while *Coarctatus* is generally of small size, and distinctly contracted behind the post orbitar. Both in clear soundings are found free of attachment of foreign substances. *Coarctatus* is sometimes taken in shingly and weedy bottoms, where its carapace and legs become thickly coated with small fuci, zoophytes and sponge concealing its true outline, hence it has been mistaken for the young of *Pisa tetraodon.*

Maia Squinado (thorn back crab) has been obtained of large size, in the trawl net, Dingle Bay. A very large and beautiful specimen was taken, similar to those on the cost of France and the Mediterranean, where it is known as *Araignee de mer.* Though rejected in Ireland, it is by no means unpalatable. The species with the absence of spines on the surface, *Maia verrucosa,* Edwards, is not unlikely to be met on the south-west coast.

The genus *Eurynome,* of which there is but the one species, *Aspera,* has been dredged in deep water, outer Blasket sound, coast of Kerry. It is an exceedingly lively and pretty species, the form of the carapace not unlike to *Hyas,* but covered with tubercles. The peculiarity of the tubercles, and their rich rose-tints, give to it the name of the strawberry crab. It must constantly be observed the frequency of species on our south-west coast that are peculiar to the shores of Cornwall and of Devon.

I now touch upon a genus of more than ordinary interest, and definition; of interest with regard to the extreme rarity of some of the species, and of definition of the confusion that has arisen in the descriptions of specific forms—The genus *Xantho.*

Three species have been described as British—*X. florida, X.*

rivulosa, and *X. tuberculata.* Of the first (Montagu's crab), the species not uncommon being frequently taken under stones, between tide-marks, on the southern and western coasts. It is the larger species of the three, and subject to variation of colour of the carapace and claws. In the marine fauna of the coast of Clare, Dr. Kinahan mentions its occurring under stones about half way down the littoral zone. Of *Xantho rivulosa,* he says but very little appears to have been known of either its distribution or habits. William Thompson only gives the authority of Colonel Portlock, who obtained one specimen in July, 1839, in the county of Antrim. Understanding its extreme rarity, others in the locality were sought for, but in vain. Kinahan observes that it may be considered as frequenting the southern, western, and north-eastern coasts, but in such instances, I would be doubtful of its identity, and of its separation from *X. florida* as a sub-littoral species.

In Professor Kinahan's paper, read before the Natural History Society of Dublin, 12th December, 1876, on *Xantho rivulosa* (Risso's crab) and other decapodous crustacea, occurring at Valentia Island, county of Kerry, he mentions it "as one of the types of a genus which, essentially sub-tropical, reaches its northern limit on the British shores—itself an undoubted member of that fauna whose scattered members attest the probability of the union of the fauna of the west of Ireland and the Mediterranean districts." Notwithstanding he assiduously sought for it, but one specimen rewarded his labours. It is not surprising that it has been so seldom met, as it is more a deep-water species, taken in the dredge in twenty-five fathoms, with broken shells and coral, off the Blasket Islands, coast of Kerry. The specimens that I obtained were very beautiful in the recent state, and numerous young were detected in the hollows of *Eschasa foliacea.* The several species that I examined were perfectly distinct from *florida,* though having some characteristics common to both. Colour of pincers and ciliation cannot be considered as distinguishing points. There are variations of descriptions, remarkably so in the *paguridæ,* that no dependence can be placed on excess of spinous processes, ciliation, or denticulations, as definite determinations—hence, in some of the specimens, though partaking much of the described characters of *rivulosa,* approach nearer to

tuberculata, the absence of denticulations being the only characters to separate it from that species. As, however, I have observed that no reliance can be placed upon such variations, I must consider that *X. rivulosa* and *X. tuberculata* to possess similiar characters, and that the latter figured in the appendix to Bell's British Crustacea, p. 359, is a very doubtful species.

In order that my views might be corroborated, I forwarded a specimen to my friend Professor Allman, F.R.S., President of the Linnæan Society, who, in the earlier stages of his scientific career, had paid much attention to the crustacea of Ireland. The object desired that he might form the comparison with the fine series of that genus in the British Museum. His examinations were most confirmatory—stating in reply, "Your view, as to the probability of *Xantho rivulosa* and *Xantho tuberculata* not being distinct species, is fully confirmed by comparison with one another of the British Museum specimens; your's is certainly the form there labelled *Xantho rivulosa,* and that so described by Bell."

The genus *Pilumnus,* of which there is but one known British species—*hirtellus,* hairy crab, is much distributed on the western and southern coasts. In rocky pools, at the West Blasket Island, it is very numerous, and where I obtained beautiful specimens of the Cornish sucker—*Lepidogaster cornubiensis,* and also *bimaculatus.*

Similarly only one species of the genus *Pirimela* is known, the *denticulata* of Leach. This beautiful little species is richly variegated, the colours assuming varied tints, in different specimens. It is rather rare, taken in deep water, and is an exceedingly active crustacean. When placed in a bowl of sea-water with other specimens, it voraciously attacked minute specimens of Mysis and Hippolyte.

Carcinus mœnas, the common shore crab, is so well known to every shore-paddling urchin, that no remark is necessary, beyond the notice that the only fine specimens are obtained in deep water with a small trawl. It is found in the deeper soundings of the harbours of Dingle, Ventry, and Valentia, and also of Smerwick and Brandon. In those localities it is obtained of good size, and also the velvet swimming crab, *Portunus puber.* Both, though rejected in Ireland, are considered in France delicate

eating. The former known as Le Crâbe enragé—the *Portunus* puber, *Cancer velutinus* of Pennant, as Crâbe à laine of the French.

The genus Portumnus, of which there is but the one species, *variegatus*, I have not yet met on the southern or western coasts. It is reported as a most common species along the sandy shores of Great Britain. William Thompson remarks how extremely local it is, and that he had not met it on the Irish Coast, though the localities dredged over were sandy, and off extensive beaches of the same nature. Dr. Kinahan, in his list of the Dublin Crustacea, mentions that it has been thrown ashore on Merrion Strand, after easterly gales.

The Portunidæ, among which are enumerated the several species of the genus *Portunus*, more than ordinary care is necessary in the decision of species, and their affinities to each other. Indeed the views entertained by eminent carcinologists would render it necessary to have the means of examination of an extensive series of the species.

Portunus corrugatus described in Bell is by no means of common occurrence. I have not seen in collections specimens so decidedly distinctive as those I have obtained in deep water in Dingle Bay. The carapace is broader than the figure given in Bell, and the elevated ridges, and adpressed hairs fringing each line, are more decided. The colour is a rich reddish brown, the fore-legs marked with brighter red, and with minute crenulated scales fringed with hairs. In the recent, or living state, it is the most beautiful of the series.

The only specimens that William Thompson had seen were those in the Ordnance collection from Larne and Carrickfergus. In the collection of J. V. Thompson, the P. Corrugatus, as obtained in the Harbour of Cove, is the wrinkled variety of *P. Depurator*, and these mistakes have been continued in the naming in some collections. Kinahan states as having obtained *P. Corrugatus,* in Bangor and Ballyholme Bays; and Mr. Hyndman, in twenty fathoms in Belfast Bay. Of the other species of *Portuni*, viz.—Arcuatus, depurator, marmoreus, holsatus, and *pusillus,* all have been obtained on the south-west coast. *P. Holsatus,* obtained in Dingle Bay, appears the more rare. A single specimen only was met by Dr. Kinahan off Whitehead, given in his list of the

dredgings of Belfast Bay. It is mentioned by William Thompson as observed in the same locality, and as the species *lividus*, by Dr. Ball, in Dublin Bay. As I have observed different views have been given with regard to the special *marmoreus, holsatus,* and *corrugatus,* it will be necessary that a careful collection should be formed to note and to decide upon their true definitions.

Before concluding the list of the Portuni, I have much gratification in recording as Irish, *Portanus longipes,* Risso. This decidedly distinct species is characterized by the length and slender proportions of its legs, and by a well marked ridge across the carapace, terminating at each margin with a strong spine. It is truly a Mediterranean species, and with others strongly bear out the geographical distribution of Mediterranean and Lutilanian species on our south-western shores, and with those of Cornwall. This rare Crustacean is figured and described in the appendix to Bell's British Crustacea, p. 361.

The genus *Polybius,* of which but a single species is as yet known, first found on the coast of Devonshire, and the specific name given to it by Leach—Henslowii, of its discoverer Professor Henslow. It has been taken by my friend, Professor Allman, at Crookhaven, coast of Cork, swimming amid shoals of Acalephæ, a strong surface swimmer. It is not recorded in Bell's work as an Irish species.

The genus *Gonoplax,* similar to Polybius, as rising to the surface, was taken by me in thirty-eight fathoms, Dingle Bay; though two species are described, *Angulata* and Rhombrides, they are merely varieties, only distinguishable by the latter having a kind of protuberance on the angles of the carapace, the former with two spines.

The fishermen recollect having seen a similar crab taken in the net when fishing for herrings in Ventry Harbour. *Gonoplax angulata* is a rare species. A single specimen was shown to Dr. Kinahan, which had been thrown ashore near the Quay, at Valentia, after a heavy gale, but he failed to find one.

Of the genera *Pinnotheres* and *Ebalia,* all the species have been taken on the south-west coast, and frequent in deep water in the outer Blasket Sound. With *Porcellana longicornis,* in the young states, they are found in the cavities of the coral *Escharafoliacea.* I have taken *Ebalia Pennantii* of a beautiful rose colour.

It is remarkable of these very delicate and minute species, how varied and beautiful are their tints, though found in very deep water. I have often with intense admiration viewed those productions of minute and fragile forms, taken even from depths of seventy fathoms; and where wild ocean seas roll over them with fearful grandeur. Strikingly are those vivid colours seen in *Pinnotheres Ebalia,* and species of *Hippolyte,* as also in the larger species Osops Prawn, *Pandalus Annulicornis.* It is only when captured that their beauties are so marked and observable, for in the spirit preparations their beautiful tints vanish.

It reminds me of the author of "Bible Teachings in Nature"—whose beauties of composition and truthfulness cannot be surpassed:—"It is a remarkable circumstance that the most brilliant colours of plants are to be seen on the highest mountains, in spots that are most exposed to the wildest weather. The brightest lichens and mosses, the loveliest gems of wild flowers, abound far up on the bleak storm-scalped peak."

Atelecyclus heterodon, circular crab, was obtained by me some years since on the shore of Ferriter's Cove, co. Kerry, after a gale. It is with several others included in the list of donations to the Natural History Society, as stated in proceedings 13th March, 1857. It is a deep-water species, though given in Dr. Kinahan's list of Dublin Crustacea, as found by him in the young state under stones at Merrion.

Corystes Cassivelaunus, the masked crab, has been found on sandy beaches after gales. It is a remarkable genus. The carapace is oval, with lateral spines, the antenno and fore-legs of the male longer than the body. I have taken the male Corystes in the trawl net, Dingle Bay. The female in point of size materially differs.

The genus Thia, *Thia Polita,* has only so far been met on a sandy beach, Galway Bay. The figure in the appendix to Bell, p. 365, is more characteristic of the Mediterranean species than those of Galway Bay, which are smaller. This rare species was first found by the late William M'Calla in 1845.

Having so far remarked on the first order, *Decapoda,* sub-order *Brachyura,* it must be obvious the variable characters of species, and how little dependence may be placed upon distinctions solely from denticulate, spinous, or hirsute developments. Such states

will be seen very apparent in the next sub-order, *Anomoura*, bearing out the sound observations of Professor Bell in his valuable work on British Stalk-eyed Crustacea; in the introduction to which he says, "It will be found that in scarcely any other class of animals is there greater variety of form and structure, or more striking apparent anomalies in the modifications of the typical plan of organization, or in some cases greater difficulties in ascertaining the true homologies of the different elements, than in the present, in fact there is scarcely any group of animals in which the homologies are more recondite, the variations and the habits and requirements of the animals more beautiful and instructive."

SHORT REPORTS FROM THE CHEMICAL LABORATORY OF TRINITY COLLEGE, DUBLIN.

BY

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No. V.

On the Rapid Estimation of Urea.

(Read March 19th, 1877.)

A DISTINGUISHED physician, who wished to make frequent determinations of the urea daily excreted by a patient, requested me to devise a method which would enable him to make the desired estimation—(*a*) rapidly, (*b*) with sufficient accuracy for ordinary clinical purposes, (*c*) with simple and easily constructed apparatus, and (*d*) without the use of a balance or of any measuring vessels other than the fluid ounce and minim measures which a medical man is in the habit of employing.

This interesting practical problem was solved in the manner I shall presently describe, and the results obtained by the use of the method devised have been so satisfactory as to lead me to expect that it may be found generally useful where a high degree of accuracy is not desired.

Before concluding this paper, however, I propose to describe a less simple plan for the estimation of urea than that just referred to; but one which is capable of affording results of greater precision.

In both the methods mentioned I take advantage of the now well-known reaction of sodic hypobromite with urea. When a strongly alkaline solution of sodic hypobromite is added to a liquid containing urea, the latter suffers rapid decomposition into water, carbonic anhydride, and pure nitrogen gas. The carbonic anhydride is not evolved as gas but is absorbed, with formation of sodic carbonate, by the free alkali of the liquid used to effect decomposition; the nitrogen is evolved in the

gaseous condition, and its bulk determined either indirectly or directly, the volume of nitrogen produced thus serving as a measure of the urea from which it was derived.

The equation which expresses the change just referred to is the following:—

$$\underbrace{CO''N_2H_4}_{\text{Urea}} + \underset{\substack{\text{Sodic}\\ \text{Hypobromite}}}{3\,(NaBrO)} + 2\,(NaOH) = 3\,NaBr + Na_2CO_3 + 3H_2O + 2\,N.$$

The use of calcic hypochlorite, or solution of "chloride of lime," in effecting a similar decomposition was pointed out by Dr. E. W. Davy,* and it has been recently shown by Yvon† that the hypochlorite used by Davy is more effective than the sodic hypochlorite, but it does not evolve the whole of the nitrogen and is irregular in its action. Knop, and after him Hüfner,‡ and many others, have shown that the sodic hypobromite is greatly to be preferred to any of the hypochlorites, as the decomposition of urea is almost complete, and progresses regularly and rapidly without the aid of heat; hence I use the hypobromite as the basis of the plan of operating now to be described, and in this respect agree with Hüfner, Russell and West, R. Apjohn, Blackly, (Dupré, and with Simpson and O'Keefe)§ in the methods they have proposed for urea estimation.

The different methods devised by the above-named chemists all serve for the *direct* measurement of the volume of nitrogen evolved during the action of the hypobromite on urea, and involve the use of specially graduated tubes for the reception and measurement of the pure gas. My plan is essentially different, as the gas evolved, which is scarcely soluble in water,‖ is made to displace its own volume of that liquid, and the latter is then easily measured in any ordinary vessel, such as a tall and well graduated drachm measure.

The apparatus may be most conveniently described as consisting of two distinct parts—A, the generating vessel (see annexed wood-

* Journal of the Royal Dublin Society and Phil. Mag. [4] Vol. vii., p. 403.

† Journal de Pharmacie et de Chimie. [4] Vol. xxiv.

‡ Journal für Praktische Chemie. [2] Vol. iii., p. 1.

§ Published since this paper was read.

‖ According to Bunsen, water dissolves only 0·01478 of its volume at the mean temperature and pressure (Bunsen's *Gasometry*, p. 286).

cut, Fig. 1), and F the small gas holder from which water is expelled by the nitrogen entering from A.

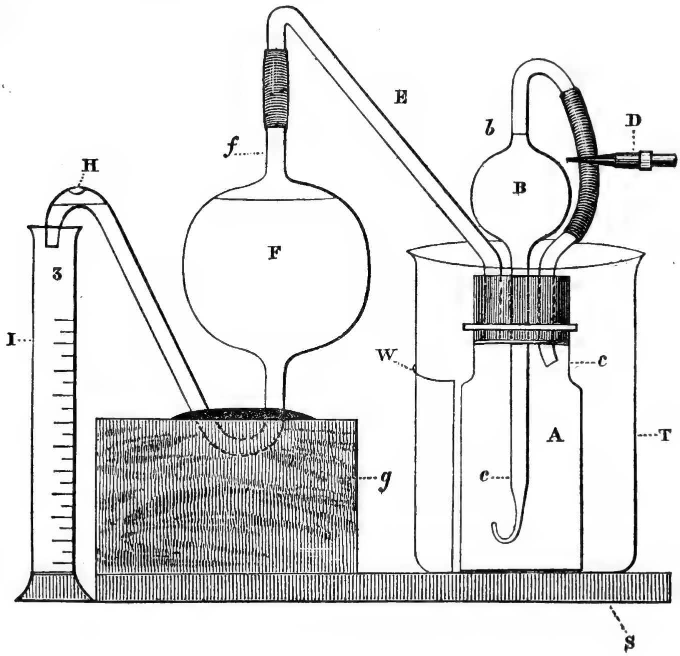


FIG. 1.

Gas generating vessel.—This is an ordinary two-ounce wide-mouthed bottle, fitted with a good india-rubber cork, pierced with three holes. Through one of these holes the gas delivery tube E passes, and through another the small piece of bent glass, tube C. The heat afforded by a spirit lamp suffices for bending these tubes from straight pieces, and for the conversion of an ordinary bulb pipette capable of holding rather more than one fluid ounce into a vessel of the form B.

The delivery tube of the pipette is first passed through the remaining hole in the cork, and the end of the tube then drawn out and recurved, as shown at *c*; the tube above *b* is bent so far down as to admit of its being connected by means of an india-rubber tube with the outer extremity of C. At D the india-rubber tube is securely clipped by a small artery forceps with broad jaws. When the cork carrying the tubes just described is secured in

the bottle, the generating vessel is complete. When an estimation is in progress the bottle A is placed in a tumbler T (or beaker), containing cold water at a temperature of 52° F., as nearly as possible.

The gas receiver.—This is easily constructed from a large pipette whose bulb F is capable of containing about three fluid ounces. The tube *f* is cut off so as to admit of being securely joined to the tube E of the generating vessel by means of an india-rubber connector. The delivery tube is then bent, as shown, and at the point H a little hole is made. A groove cut in a block of wood *g* receives the bent tube of the little gas holder, which is then easily secured in its place by any suitable cement—common sealing wax, for example. Thus, with the aid of the two pipettes, cork, and tubing, which can be easily procured through a druggist for about 3*s*., a medical man can construct his own ureometer.*

When in use the block *g* is secured to the board S on which the beaker T stands held by the wire W.

Mode of using the Apparatus.—The vessels A and F are disconnected, and F filled with water until it overflows and the excess has ceased to drip from the tube under H. The cork is removed from the bottle A, and two fluid drachms of the liquid to be tested measured off in a tall minim measure, and then poured into A; one drachm of water is next used to rinse the liquid adhering to the sides of the measuring glass into the bottle A; the total volume in A therefore should measure about three drachms.† For a reason which will presently appear, it is desirable that no more water than one drachm should be employed. If a pipette delivering two drachms be used, a drachm of water should be added; but the pipette need not be rinsed with it. The next step is to fill the pipette B with the re-agent which evolves the nitrogen of the urea. For this purpose a suitable vessel—a wine-glass for example—is filled with the hypobromite liquid;‡ the forceps D

* Messrs. Yeates & Son, of this city, supply a neat form of my apparatus ready for use.

† The measures used should be good, the two-drachm and two-ounce vessels agreeing with each other. The amount of reliance which can be placed upon the results depends in great part on the accuracy of the measures.

‡ This solution is prepared as follows:—Dissolve 4 ounces of the solid caustic soda of the shops in 10 fluid ounces of water. When the soda has dissolved and the liquid cooled to 60° F., add gradually 1 fluid ounce of bromine. The test solution is then ready for use. It should be kept in a cool place, and away from the light.

are removed from the india-rubber tube, but are placed close at hand, and a piece of vulcanized tubing, five or six inches long, attached to the end of the glass tube C; suction is then applied by the mouth, when the curved end *c* of the pipette is immersed in the hypobromite. The pipette is thus easily filled by suction with the re-agent up to the mark *b*. The forceps D are next applied to the connector, as shown, *before* the lips are withdrawn from the india-rubber tube attached to C; the suction tube may then be removed from *c*, as the liquid is retained in B by atmospheric pressure, provided D pinches the tube well. Having washed the end *c* by pouring a little water over it, the cork carrying all its apparatus is securely inserted in the bottle A, the latter placed in the beaker T containing enough water to cover the cork when A is pressed down, and the tube E securely connected by the tightly-fitting india-rubber tube with *f*. While connecting the generator and receiver a little water is necessarily expelled from the tube beyond H, but this water is thrown away and the *dry* two-ounce measure I then placed under the spout.

Up to this point the hypobromite has not been allowed to come in contact with the urine, but now on removing the forceps D the hypobromite flows out from *c* and rapidly mixes with the urine, the urea of which yields up its nitrogen gas with effervescence. As the gas evolved has no exit save through E it displaces from F its own volume of water, which falls into the vessel I, and can then be measured, when no more water is expelled. The effervescence ceases after five or ten minutes, according to the temperature.

It is essential to good measurement that the pressure within the apparatus should be the same at the end as at the beginning of the experiment; in order to secure this, the simple plan is adopted of placing a wedge under the board S at the end indicated, which is thus so tilted that the eye placed at a point a little below D, and looking immediately above the surface of the water in F, can just see the bend of the tube under H. When the pressure within and without has been thus equalized the amount of water expelled is the measure of the nitrogen evolved in A, for we may in a test of this kind neglect the extremely minute proportion of the nitrogen which has been dissolved by the water.

When it is desired to correct for temperature and pressure, by means of the usual formula, it is now necessary to disconnect E and *f*, and to pass the bulb of a small thermometer through *f* into the gas over the water in F; after a minute or so the temperature may be read off and recorded, and the barometric reading made at the same time. In ordinary clinical experiments, however, the correction for temperature may be neglected when a thermometer in the room stands near to 52° F. The neighbourhood of a fire or stove must be avoided in making the estimations of urea.

In measuring the water expelled we may either read off the volume in drachms or sixths of a drachm; but since ordinary cylindrical two-ounce measures are rarely graduated to less than half drachms, the *best* plan is to pour the excess over a definite number of drachms into a tall two-drachm measure, bearing in mind that every ten-minim division represents the sixth of a drachm.

I find as the result of a large number of direct experiments with a standard solution of pure urea, some of which will be given farther on, that *one grain of urea produces sufficient gas at a temperature of* 52° *F. and a barometric pressure of* 30·06 *inches to expel* $6\frac{4}{6}$*th drachms of water*, the volume of liquid in the bottle A being three drachms, and the hypobromite added, ten drachms.

It may be mentioned that measures of capacity need not be employed in the determinations of urea, as the water expelled may be received in any suitable vessel which has been previously weighed. At the end of the experiment the vessel and expelled water are weighed. When the estimation was made under the conditions above named *one grain of urea was found to expel, as a mean,* 365 *grains of water by weight.* This number is easily remembered as it happens to be identical with the number of days in a year.

Effect of the degree of dilution upon the determination of urea.—An apparently trifling observation led me to examine the effect of dilution upon the yield of nitrogen obtainable from a constant weight of urea, and the results arrived at are stated in the table given below.

The quantity of pure dry urea operated with in each of the following experiments was 2·222 grains, and the same volume (*i.e.* ten fluid drachms) of a single sample of freshly prepared sodic hypobromite was added in each case. The experiments were completed within three and a half hours, and care was taken to avoid changes of temperature as much as possible; hence, while the barometer remained steady at 30·06 inches, the temperature varied within such very narrow limits (between 50° and 52° F.) that corrections for alterations of volume were unnecessary, as extreme accuracy in the measures of the water expelled was not attainable with the vessels advisedly employed, as I desired the results to be of such a kind as a medical man could easily obtain in his own study.

TABLE.

Experiment No.	Pure, dry Urea used in Experiment.	Volume of Water used to dissolve Urea in A.	Volume of Water expelled from F.
1	2·222 grains, .	0 drachm, .	$15\frac{1}{6}$ drachms.
2	,, .	1 ,, .	15 ,,
3	,, .	2 ,, .	$14\frac{5}{6}$,,
4	,, .	2 ,, .	$14\frac{5}{6}$,,
5	,, .	3 ,, .	$14\frac{4}{6}$,,
6	,, .	3 ,, .	$14\frac{4}{6}$,,
7	,, .	4 ,, .	$14\frac{3}{6}$,,
8	,, .	5 ,, .	Lost.
9	,, .	6 ,, .	14 + ,,
10	,, .	7 ,, .	$13\frac{5}{6}$,,
11	,, .	8 ,, .	$13\frac{4}{6}$,,
12	,, .	9 ,, .	$13\frac{3}{6}$ + ,,
13	,, .	10 ,, .	$13\frac{2}{6}$ + ,,

The weight of urea taken for each experiment is capable of affording a volume of moist nitrogen gas at the temperature and pressure above stated, which would expel $15\frac{4}{6}$th drachms of water. The maximum volume obtained from that weight of pure dry urea was $15\frac{1}{6}$th drachms. Thus there is a minimum loss of 3·3 per cent. The maximum observed loss in the foregoing experiments amounted to 14·9 per cent., and occurred in the experiment in which the above-named weight of urea was dissolved in ten drachms of water. The loss within the above limits is

tolerably regular, as the volume of nitrogen is diminished by $\frac{1}{6}$th of a drachm (nearly) for each drachm of water added to the urea in the decomposition vessel A.

The loss of nitrogen referred to is, doubtless, due in part to solution of the gas, but it is chiefly attributable to the regular diminution of the strength of the oxidizing agent used—the hypobromite solution—and to a corresponding increase in the extent of the secondary changes which are known to occur in the diluted liquids, and which involve a loss of gaseous nitrogen. Much of the error arising from the latter cause is avoided by adopting the plan of employing a constant volume of liquid; hence the recommendations already made that two drachms of urine should be measured into the bottle A, and the measure rinsed out with not more than one drachm of water. The total bulk of liquid in A ought then to measure as nearly as possible three drachms. Even when the sample to be tested is measured with a pipette, it is well to add one drachm of water from an ordinary measure in order to bring up the total volume of liquid to the amount recommended.

When the simple precautions are taken which I have already mentioned, the little apparatus described in this paper will enable a considerable number of estimations of urea to be made with rapidity, and with sufficient accuracy for ordinary clinical purposes. When very precise determinations are required, Liebig's process must be resorted to, as all the methods in which hypobromites or hypochlorites are employed are liable to the errors pointed out above; the accuracy of the results are also affected by the action of the re-agent used on uric and hippuric acids, creatinine, and other nitrogenized compounds. On the other hand, when we desire to ascertain the total amount of nitrogen excreted by the kidneys, it is necessary to resort to the precise method of estimation which I communicated to the Surgical Society of Ireland.*

Estimation of Urea by direct determination of the Nitrogen gas evolved by Sodic Hypobromite.

The piece of apparatus now to be described was exhibited at a meeting of the Scientific Club in 1871, and has proved most useful

* *Vide* Medical Press and Circular, May 13th, 1874, p. 402.

for the estimation of urea by the hypobromite method, and, with a little modification, for the estimation of carbonic acid in carbonates, and for other similar purposes. I shall only refer at present to its use in ureometry. In this apparatus the nitrogen evolved is directly measured as gas under conditions which admit of very accurate determinations of volume in cubic centimetres.

The apparatus is shown in section in Fig. 2. The stand A supports a tall glass cylinder B. Through the large india-rubber cork which closes the lower opening of the cylinder the U tube *c* is passed, great care being taken to avoid breaking the small T connector *c*. The outer limb of the U tube is provided with a glass tap T. The limb within the tall glass cylinder is sufficiently wide to contain 150 cubic centimetres in the expanded portion, which, in my apparatus, measures sixty centimetres in length. The graduation cannot be conveniently carried beyond fifths of a cubic centimetre. At the point shown an india-rubber tube *g* is attached, which can be closed at will either by a good clip or by a stopper of glass rod. The glass side tube *c* serves to connect the measuring apparatus in the manner shown with the generating vessel D, which is a long and wide glass tube placed within the cylinder. The glass T tube E is connected by means of rubber tubing with *c*, while one limb passes through the india-rubber cork of D, and the other is connected by another piece of rubber tubing with the fine tube of the long pipette F (of about 20 c.c. capacity), which projects through the cork. This connexion must be sufficiently long to admit of the clip being applied as shown.

The large glass cylinder B is filled with water, in order to maintain a steady temperature, the value of which can be known by means of a thermometer immersed in the water.

A determination is made with this apparatus in the following way:—Having disconnected the T tube E from *c* and the clip, the generating tube D is taken out of the water of the cylinder, the cork carrying the pipette, &c., withdrawn, and then five cubic centimetres of the urea solution introduced into the tube D. Before replacing the cork the pipette F is filled with hypobromite solution by suction above E, while the small glass tube opening on the under side of the cork is closed by a finger; the

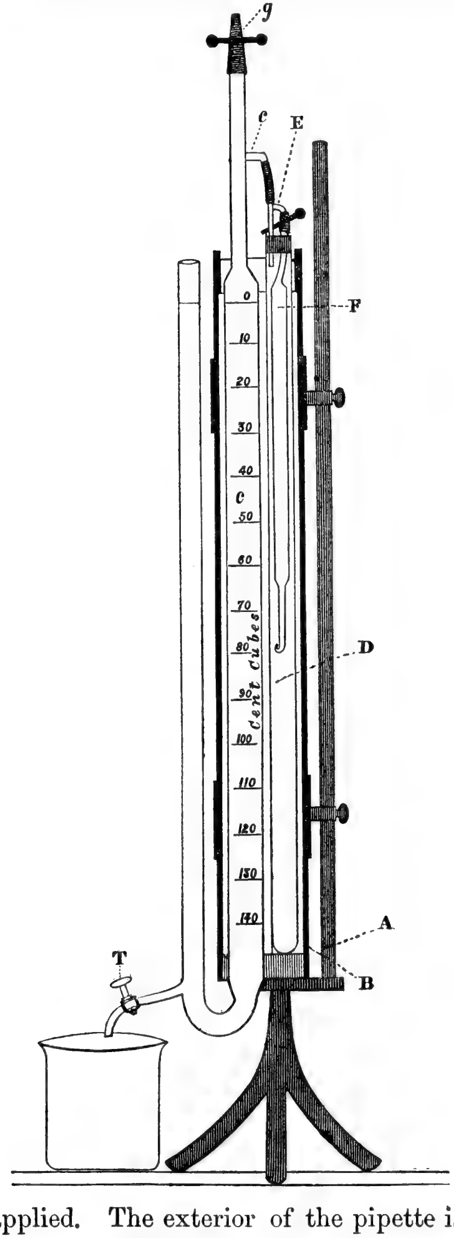


Fig. 2.

clip is then applied. The exterior of the pipette is now washed with a little water, and the cork, with the apparatus attached, is

then replaced in position; the tube D again immersed in the water of the large cylinder, and the connexion between E and *c* securely made. Before making the connexion the water in the graduated tube should stand at the zero of the scale, but after making the joint the pressure within the apparatus is usually greater than that without. As the air in the tube D cools down to the temperature of the surrounding water, contraction takes place; but should the water not return to the zero, equilibrium is at once restored by opening the fine india-rubber tube *g* for a few seconds, and then closing in such a manner as to prevent any possible escape of gas.

The hypobromite is brought in contact with the urea solution by removing the clip from the india-rubber tube connected with the pipette; the re-agent then falls from a considerable height, and mixes thoroughly with the liquid at the bottom of the tube D. Nitrogen is evolved and displaces water from *c*, the water being maintained at the same level in both limbs of the U tube by allowing the liquid displaced to run off by means of the tap T. When the evolution of gas has ceased, the water level is adjusted by means of the tap, and the volume of gas produced in the reaction then read off on the graduated tube *c*; the temperature of the water in the cylinder B is then ascertained, as well as the height of the barometer at the time. From the data thus obtained, the volume of dry nitrogen at 0° C. and 760 mm. can be easily calculated by the usual formula.

THE SUBSTITUTION OF AN ALKALINE BASE IN CHLORIMETRY.

BY

JOHN SMYTH, JUN., C.E., F.C.S.

[Read May 21st, 1877.]

IN Chlorimetry, I consider that the use of a milky mixture of the sample of the bleaching powder to be tested, is a great inconvenience and source of loss.

In the case where measured portions of the milky mixture are added to the chlorimetrical substance, there is a loss of the sample, from portions adhering to the hand or other stopper, during the frequent agitations, which are necessary, and there is a difficulty in maintaining an equality in strength, between the earlier and later added portions of the contents of the burette.

The same objections prevail, where a measured portion is taken from a prepared stock mixture of the sample of bleaching powder, and acted upon by the chlorimetrical substance, as agitation is also necessary. In short in any case the reaction is not so palpable and satisfactory with a milky as with a clear liquid.

I was therefore glad to find a simple method of always obtaining a clear solution of the bleaching powder, containing all its chlorine, by merely dissolving it in an alkaline solution.

I was led to adopt this method from the following circumstance. In the north of Ireland a solution of the bleaching salt of soda is used instead of one of lime for the finer fabrics of linen in the bleaching process, since the former liquid parts more slowly with its chlorine than the latter, a prolonged action is secured, and thereby the strength of the fabric is less affected.

This alkaline bleaching liquid has long been manufactured in that district, formerly by the direct addition of chlorine to an alkaline solution; but since the production of bleaching powder at a cheap rate by the reaction of carbonate of soda on a solution of the bleaching powder.

In determining the amount of available chlorine in this liquid

from time to time by the usual methods, so much more satisfactory results were obtained than in testing bleaching powder, that I made a number of investigations to determine whether correct and expeditious results could be secured by converting the latter into the former. The result was that, at least as accurate determinations of the amount of available chlorine in the several samples were obtained by this means as by using the milky solution.

As an excess of alkali is no inconvenience in testing, and thereby the liquid settles more readily and is more easily filtered, the usual mode of procedure is to dissolve 240 grammes of soda crystals ($Na_2CO_3+10aq.$) in one litre of water. This amount of alkali will be found sufficient for the strongest samples. One litre of this alkaline solution will test ten samples of bleaching powder where 10 grammes are operated on, and twenty samples where 5 grammes are taken. I generally weigh out 5 grammes of the sample of bleaching powder, than take 50 C.C. of the above alkaline solution, a little of which I add to the powder in a mortar, and triturate till there results a pasty mass; next the mortar is nearly filled with the alkaline solution, and the contents of the mortar rubbed up again with the pestle and transferred to a beaker. The remaining part of the alkaline solution is used for washing out the mortar into the beaker: water may be used to complete the washing if there be not enough of the alkaline solution.

The contents of the beaker are allowed to settle a few minutes, and the quickness with which they do so, is a measure of the good quality of the lime used in the manufacture of the bleaching powder. Bleachers much prefer the lime bleaching liquors (solution of bleaching powder,) and alkaline bleaching liquors (the liquid I am now describing) which settle quickly. The supernatant liquid is then passed through a filter, and the precipitated carbonate of lime stirred up with some water and then thrown on the filter, the first portion of this filtrate should be received in a separate vessel as some of the fine precipitate is liable to pass through, but soon cease to do so, when these portions can be filtered over again. The beaker and filter is then washed; and the washings are known to be complete when they no longer give a precipitate with nitrate of silver or discharge

the blue colour of dilute solution of indigo. The latter test is the most convenient for bleachers who generally use indigo for testing their bleaching vats for chlorine, and as the washing is easily effected, is sufficiently accurate.

The filtered liquid to which the washings are first added is then made up with water to 500 C.C.

It is easy to know when this liquid contains an excess of alkali, by the addition of a small portion of the lime bleaching liquid (sol. of bleaching powder,) which if such be the case gives a white precipitate (carbonate of lime).

For each examination 50 cub. cent. of this liquid are taken, and the per-centage of chlorine determined either by Gay-Lussac or Penot's method with arsenious acid, or by Otto's method with protoxide of iron or indeed by any of usual methods. In the methods with arsenious acid, I find it a great improvement to dissolve the arsenious acid in glycerine instead of potassa or soda. If there is not time to filter tolerably accurate results can be obtained by making up the unfiltered liquid to 500 cub. cent., indeed more accurate I consider than by the mere milky solution of the bleaching powder.

Made up of this strength and filtered the alkaline bleaching liquid is clear and colourless of a sp. gr. of 1·007. I have made it however of a sp. gr. of 1·233 containing one of chlorine to nine of the liquid, which in this case is slightly green. It has a pleasant oily feeling to the touch, contrasting favourably with the rough unpleasant feeling of the lime bleaching liquor.

Its bleaching effect is very much altered by a slight departure on either side from its neutral point (viz. when the addition of either an alkaline or lime solution will cause *no* precipitate).

In the manufacture of this liquid for bleachers, the commercial carbonated soda ash is used with bleaching powder.

ON QUARTZ WITH A PEARLY LUSTRE.

BY

RICHARD J. MOSS, F.C.S., Keeper of the Minerals, R.D.S.

[Read May 21st, 1877.]

At a former meeting I exhibited some specimens of crystallized quartz, with an unusual pearly lustre; since then I have carefully examined these specimens, and others recently obtained, and finding that very erroneous opinions have been entertained concerning the nature of the lustrous coating, I propose to state briefly the results of my examination.

The Rev. George Harrison Reade, who presented the specimens to the Society, states that he found them "imbedded in a ferruginous mud, in a fissure of a solid limestone rock, in the demesne of Rock Forrest, near Mallow, county Cork." The largest specimen consists on one side of an irregular mass of ferruginous quartz, which has evidently been deposited on a bed of calcite, for there are impressions of crystals in the quartz of which I have taken casts, and found that the angles correspond with those of the more common rhombohedral forms of calcite.

The hexagonal pyramidal crystals on the other side of the mass present no notable peculiarity, except in lustre. Instead of the usual vitreous appearance, they exhibit a pearly lustre, owing to a very perfect reflection of light. This lustre is not evenly distributed, as occasional small patches on the faces of the crystals exhibit the normal lustre. On examination the pearly appearance is found to be confined to a coating, varying from an exceedingly thin film to a layer of about a millimetre in thickness. This coating can be detached in fragments from some of the faces without much difficulty; the underlying surface then exhibits the usual vitreous lustre. The outer and inner surfaces of the detached layer are almost identical in appearance. On chemical examination I find that the coating consists only of silica, it does not contain any other substance in appreciable quantity. A microscopical examination shows that the coating consists of

several laminæ varying in thickness, the thinner laminæ sometimes passing into thicker layers; there are some small spots on the faces of the crystals, where the laminated structure entirely disappears, thus producing the patches of vitreous lustre already referred to. A crystal immersed in aqueous hydrofluoric acid soon loses its peculiar lustre, the coating being irregularly dissolved, the faces of the crystals are left rough and uneven. In some places the coating exhibits numerous cracks, which intersect irregularly and correspond more with a vitreous than with a crystalline structure. As the crystals are simply capped with laminæ of quartz, I concluded that this "Pearl Quartz," as the Rev. Mr. Reade proposes to call it, must be regarded as a variety of cap-quartz, the lustre being entirely due to the great reflection of light from the surface of the laminæ of which the caps are composed. The origin of this peculiar structure cannot, of course, be determined with certainty; it is, however, obvious that the growth of the crystal has not proceeded under conditions of uniform regularity, on the contrary it would appear that occasional changes in the conditions of growth have led to the deposition of thin films of some foreign substance on the faces of the crystals. The succeeding growth of quartz has either been separated in this way from the former growth by a thin layer that has subsequently disappeared, or else it has been pseudomorphous after the coating. Considering that the quartz was associated with calcite, and also the frequency with which this mineral is found as an incrustation on quartz, it is not improbable that the substitution of quartz for calcite is the true origin of the laminated structure. There are crystals of siderite embedded in some of the masses of quartz. This mineral also is frequently replaced by quartz.

ON THE PENETRATION OF HEAT ACROSS LAYERS OF GAS.

BY

G. JOHNSTONE STONEY, M.A., F.R.S., Secretary Royal Dublin Society.

[Read 21st May, 1877.]

(*Abstract.*)

THE name *penetration* is suggested in this communication for the way in which heat leaks away across the curtailed Crookes's layer which comes into existence when gas intervenes between a heater and cooler brought sufficiently close.

The laws of the escape of heat by penetration are approximately traced, and it is shown that the rate of cooling which occurs from this cause will often be considerable.

It is further shown that the laws of the escape of heat by penetration completely account for a large body of remarkable results obtained upwards of thirty years ago by De la Provostaye and Desains when experimenting upon the escape of heat from thermometer bulbs placed within exhausted receivers of different sizes. They found that when the receiver was small, and when the exhaustion passed a certain point, there was a more rapid cooling than could be accounted for by Dulong and Petit's laws for radiation and convection. When the exhaustion was continued this additional loss of heat rose gradually to a maximum after which it rapidly fell off, but still remained of considerable amount at the lowest tensions they could command, when the receiver was only 6 cm. across. All these results are shown to be in conformity with the deductions from the theory.

It is also shown that the abnormal law for convection in hydrogen which Dulong and Petit derived from their experiments, is accounted for by assuming that the law for convection is the same or nearly the same in all gases, but that what these physicists supposed to be entirely convection was in reality the mixed effect of convection and penetration.

It is moreover shown that many observations which have been relied on as evidence that hydrogen possesses a large conducting power for heat, in reality prove that a copious escape of heat by penetration takes place in this gas at higher tensions and to greater distances than in gases that are denser. This result has been confirmed by repeating in common atmospheric air Sir William Groves' experiment upon the cooling effect of hydrogen on a platinum wire, previously rendered incandescent by electricity. This experiment when made in the open air further shows that the Crookes's layer surrounding the incandescent wire has a thickness of much more than a millimetre.

Finally it is shown that all parts of the phenomenon of a volatile liquid in the spheroidal state are the immediate consequences of the mechanical and thermal properties of the curtailed Crookes's layer which exists between the liquid and the hot surface upon which it rests.

It is also shown that the drops which are often seen running over the surface of a volatile liquid are globules in the spheroidal state supported upon Crookes's layers; and that the extreme mobility of a very fine solid powder when placed in a hot metal dish is also due to the intervening Crookes's layer.

ON SOME REMARKABLE INSTANCES OF CROOKES'S LAYERS, OR COMPRESSED STRATA OF POLARIZED GAS, AT ORDINARY ATMOSPHERIC TENSIONS.

BY

GEORGE JOHNSTONE STONEY, M.A., F.R.S.

[Read November 19th, 1877.]

1. In a communication which I had the honour to lay before the Royal Dublin Society at its last scientific meeting, I gave some instances of Crookes's layers at ordinary atmospheric tensions,* and among them described one which accounts for the great mobility that may be imparted to a light powder by heating it in a metal capsule. It is shown that in this case the powder floats on a stratum of air which it compresses by its weight, at the same time that it maintains the requisite polarized condition of the layer by radiating away its own heat so freely as to keep itself cooler than the capsule.

2. In exactly the same way we may explain a very curious phenomenon which has been recorded by travellers in Arabia, and to which Professor Barrett has directed my attention. There is in Arabia a mountain called Jebel Nagus, or Gong Mountain, which produces sounds resembling the booming of the Nagus, or wooden gong, used in Eastern churches instead of bells. The mountain consists of a white friable sandstone, which produces to the south-westward a great slope of very fine drift sand, and another smaller one to the north. The large one is 115 metres high, 70 metres wide at the base, and tapers towards the top. It is so steep, being inclined to the horizon at an angle of nearly 30°, and consists of such fine sand, that its surface can be easily set in motion by scraping away a portion from its base or by disturbing it

* The theory of unequal stresses in polarized gas has thus fulfilled an anticipation which Mr. Crookes entertained so long ago as 1873, that whatever theory would account for the motion of radiometers would, probably, also explain the spheroidal state of liquids, and the mobility of finely divided precipitates in heated capsules; for he enumerates these among phenomena, probably due, at least in part, to the same "repulsive action of radiation" as is manifested in radiometers. (See Philosophical Transactions, vol. 164, p. 526). I have only become acquainted with this passage since writing the present paper, or, if I had seen it before, I had forgotten it, otherwise I should have referred to it in my last paper.

elsewhere. If this is done after the surface has been for a long time exposed to the sun—

"The sand rolls down with a sluggish viscous motion and the sound begins, at first a low vibrating moan but gradually swelling out into a roar like thunder, and as gradually dying away." (Palmer's "Desert of the Exodus," vol. 1, p. 218).

That heat contributes largely to the effect was proved by the valuable observations made by Captain Palmer, for it was found—

"That the heated surface was much more sensitive to sound than the cooler layers beneath, and that those parts of the slope which had lain long undisturbed produced a much louder and more lasting sound than those which had recently been set in motion."

Moreover, when the experiments were repeated on the other talus, which faced towards the North, and part of which was in perpetual shade, it was found—

"That the sand on the cool shaded portion, at a temperature of 17° C, produced but a very faint sound when set in motion, while that on the more exposed parts, at a temperature of 40°, gave forth a loud and even startling noise."

These observations were made in winter. They clearly indicate that heat renders the surface of the slope more mobile by polarizing the air between the hotter and cooler particles of the sand.

The more intense the sunshine, the more powerful must the Crookes's layers be, and the more widespread will be the effect of any accidental disturbance. And if under the fierce glare of the tropical sun the strength of the Crookes's layers becomes sufficient to lift the uppermost grains of sand, the sliding motion, with its humming, booming, and thundering noise, will spring up without visible cause—a phenomenon that sometimes occurs and has naturally occasioned much speculation.

Mr. Howard Grubb has directed my attention to another natural phenomenon which admits of being explained by the mechanical properties of polarized layers of gas. In certain states of the weather *large* grains of sand, flat pieces of shell, and even flakes of stone of quite a considerable size may be seen floating on the tide as it flows in. I saw this phenomenon myself when a boy, but unfortunately did not make a careful examination of the attendant circumstances. It is, however, easy to see the conditions which would be most favourable to its production. They are—a

very powerful sun to heat the stones and to maintain their temperature sufficiently high after they are set floating; calm air that no breeze may cool them; a cold sea to increase as much as possible the difference in temperature between the flakes of stone and the water, and the absence of waves that the heavy little barges may escape shipwreck.

I think it fortunate that I had written out the foregoing statement of the conditions indicated by the theory, before I saw the following record of observations upon this phenomenon made by Professor Hennessy. (See Proceedings of the Royal Irish Academy, Vol. I., Series 2):—

"On the 26th July, 1868, when approaching the strand at the river below the village of Newport, county Mayo, I noticed what appeared to be extensive streaks of scum floating on the surface of the water * * * until I stood on the edge of the strand, and I then perceived that what was apparently scum seen from a distance, consisted of innumerable particles of sand, flat flakes of broken shells, and the other small *dêbris* which formed the surface of the gently sloping shore of the river. The sand varied from the smallest size visible to the eye, up to little pebbles nearly as broad and a little thicker than a fourpenny piece. Hundreds of such little pebbles were afloat around me. The air during the whole morning was perfectly calm, and the sky cloudless, so that although it was only half-past nine, the sun had been shining brightly on the exposed beach. The upper surface of each of the little pebbles was perfectly dry, and the groups which they formed were slightly depressed in curved hollows of the liquid. The tide was rapidly rising, and owing to the narrowness of the channel at the point where I made my observations the sheets of floating sand were swiftly drifting farther up the river into brackish and fresh water. On closely watching the rising tide at the edge of the strand, I noticed that the particles of sand, shells, and small flat pebbles, which had become perfectly dry and sensibly warm under the rays of the sun, were gently uplifted by the calm steadily rising water, and then floated as readily as chips or straws."

The calm air, tranquil water, hot sun, and warm stones, predicted from the theory, are all recorded in these observations.

This rare phenomenon must not be confounded with the familiar one in which patches of *fine* sand float upon water in consequence of its surface tension. The surface tension of water in contact with air will not support flakes of stone of above a certain size, and those described by Professor Hennessy are at or beyond the limit of size* that could even if separate be floated by surface

* Taking the surface tension of water in contact with air as 8·25 grammes per metre as determined at 20° C. by M. Quincke, and assuming 2·5 as the specific gravity of the

tension. Hence they could not be supported by that agency *in the groups* which he describes. We are therefore forced to look elsewhere for the cause of the support of these groups; the thermal and mechanical properties of Crookes's layers show that they will suffice: and we have seen that all the conditions were present which would call Crookes's layers into existence.

Mr. George F. Fitzgerald has pointed out another very striking example. A piece of cold iron may be made to float on melted cast iron, and will even float high like cork on water. Here the difference between the temperature of the glowing mass of molten metal and the cold piece of iron is so considerable that the stresses that are developed are able to support the weight of the piece of iron while it is still at such a distance from the fiery liquid that it seems to float high upon it. What it floats on is in reality a bath of polarized air, the stresses within which both support its weight and force down the surface of the molten metal. This air-bath keeps it out of contact with the glowing mass; and, accordingly, it receives heat from below only by diffusion and radiation, in quantities far short of what it would receive from actual contact, and as it loses much heat by radiation upwards, it may be able for a considerable time to maintain a sufficiently low temperature to continue floating.

On the same principles we are to explain the safety of exploits that are occasionally performed, viz.—The licking of a white hot poker, the dipping of the fingers into molten metal, and the plunging of the hand into boiling water. In all these cases the Crookes's layers that intervene prevent that contact which would cause a dangerous scald or burn.

It is usual before performing these two latter experiments, to moisten the hand with soapy water, ether, turpentine, or liquid ammonia. All of these would have the useful effect of lowering the surface-tension of the hot liquid, and thus diminishing the extent to which it would compress the Crookes's layer.

But the most splendid example I have yet seen of a Crookes's layer is one which was first noticed by M. Boutigny, and which

stone, it follows that a circular disk, 16 m.m. in diameter and 0·85 of a m.m. in thickness would be the extreme theoretic limit that could be supported by surface tension. This is about the size of a fourpenny bit.

was shown by Professor Barrett, at the Brighton meeting of the British Association, with the improvement of adding soap to the water, an addition which seems essential to the full success of the experiment. A copper ball, some six cm. in diameter, furnished with a staple by which it can be lifted, was brought to a bright red heat, and while glowing was lowered into a large beaker of soapy water. As the ball approaches the cold surface of the water heat passes from the ball to the water by conduction or penetration* as well as by radiation; accordingly the intervening air becomes intensely polarzied, and the Crookes's stress that accompanies the polarization makes a hollow in the surface of the water. Let the ball be lowered till it is half submerged, the depression in the water is now nearly hemispherical, but not quite so, since the interposed layer of polarized gas will be thinnest at the bottom, where, to withstand the pressure of the water, it must exert most force. The stresses at any point of this polarized layer consist of a constant stress P nearly equal to the tension of the open atmosphere, acting equally in all directions, along with a variable Crookes's stress p, acting for the most part nearly in the direction of a radius of the ball; the most marked deviation from this direction being close to the horizontal surface of the water, where the action of the upper hemisphere of the ball gives an inclined direction to the Crookes's stresses, and helps to round off the surface of the water. The amount of the Crookes's pressure acting on the water will vary with the depth, being such at each point that it gives a component equal and opposite to the resultant of the pressure of the water at that depth, and of the surface tensions round the point. Whenever the Crookes's force is not quite in the direction of this resultant, there will be a free tangential component, and this must produce surface currents in the water. These, however, cannot be observed in the present experiment because they are of small amount, and too much mixed up with convection currents arising from the heat that reaches the water by radiation and diffusion.

When the ball is lowered until it is quite submerged it will be surrounded on all sides by its envelope of polarized air, thinnest at

* The heat which diffuses across a layer of gas passes under what are known as the laws of conduction if the number of gaseous molecules present is sufficiently large. If fewer molecules are present the heat passes under other laws, which may be distinguished from the laws of conduction by calling them the laws of penetration.

the bottom, where the pressure of the water is greatest, thickest above. So long as there is any communication between the polarized layer and the atmosphere, the lateral stresses within the layer will be equal to P, while those in the direction in which the heat penetrates will be $P+p$; but both of these will suffer an increase if the ball is plunged deeper after the communication with the atmosphere has been cut off. No one can see this splendid experiment for the first time without a feeling of astonishment.

A Crookes's layer formed in the same way, but without the exquisite beauty which it has in this experiment, may be seen any day in a smith's forge, whenever the smith has occasion to quench white-hot iron in water.

A phenomenon closely resembling the experiment with the glowing ball was witnessed lately by my brother and two other friends while out walking. There was a shower when they reached some rather deep water. The afternoon had become chilly, and the phenomenon that presented itself shows that the water must have retained a temperature higher than that of the air. As the rain-drops fell into the water, some of them (estimated at one in twenty) became spheroidal drops floating on the water, and of these some (estimated at one in six) were visibly submerged before floating about as spheroidal drops. They sank, perhaps about half a centimetre before they rose to the surface, and while under water looked like silvered pills, owing to the total reflection from the boundary between the water and the film of polarized air which enveloped each drop.

Several times, in the course of this communication, I have had occasion to speak of the feebleness of conduction or penetration, compared with the rapid outpour of heat which takes place on direct contact between a very hot and a cold body. This is well illustrated by an experiment of M. Boutigny, in which a spheroidal drop of water is formed inside a hot copper bottle, and the neck of the bottle partially stopped by a cork through which a thin tube passes. So long as the drop continues in the spheroidal state, a mixture of air and vapour slowly escapes through the tube in the cork, but the instant the spheroidal state ceases, and the water comes into contact with the copper, a sufficient portion of the water flashes off so suddenly into steam that the cork is driven out with explosive violence.

A still more instructive illustration of these facts is afforded by the familiar experiment, known to every smith, that an explosion will occur if a little water is dropped on an anvil, if a white-hot strap of iron is laid over the drop, and if the iron is then given a tap with the sledge-hammer. In this experiment the hot iron, when laid on the anvil, does not fit it accurately, but comes into contact only at a few points, and leaves a chink elsewhere. While the iron is descending towards the drop of water, a Crookes's layer of polarized air is formed between it and the cold water, which exerts a sufficient pressure upon the drop, both to flatten it out, and to keep it from coming into contact with the glowing iron. At this stage of the experiment the lower portion of the chink is occupied by water, and the upper portion by polarized air. The stratum of air moderates the flow of heat towards the water, so that the water is able to continue liquid by parting with as much heat downwards to the cold anvil as it receives from above, before it is itself warmed beyond the boiling point. But when the sledge-hammer descends, the soft iron yields, the chink is obliterated with a force greater than that which the Crookes's layer can support, and the glowing mass comes, in many places, into direct contact with the water. The vastly augmented flow of heat which is consequent upon this direct contact, rushes across the film of water with a speed equal to the velocity of sound in water, which will carry it across a film the seventh of a millimetre in thickness in the ten-millionth of a second. Within this brief period of time the greater part of the water is raised to a very high temperature, and its sudden conversion into red-hot steam causes the explosion.

Before concluding this communication I wish to take the opportunity of publicly thanking my scientific friends for their kindness in bringing such remarkable instances of Crookes's layers at ordinary atmospheric tensions to my notice and giving me permission to publish an account of them.

ON THE CHEMICAL COMPOSITION OF THE COAL DISCOVERED BY THE ARCTIC EXPEDITION OF 1875–6.

BY

RICHARD J. MOSS, F.C.S.,

Keeper of the Minerals, Museum of Science and Art.

[Read November 19th, 1877.]

DURING the late Arctic Expedition an extensive seam of coal was discovered in Grinnell Land, close to the winter quarters of H.M.S. *Discovery*, 81° 43′ N.L., 64° 4′ W.L. Dr. Moss, late of H.M.S. *Alert*, presented a large specimen of the coal to this Society. It is now deposited in the Museum of Science and Art. The specimen was taken by Dr. Moss from the seam at about fifteen feet from its upper surface, the estimated thickness of the seam being about twenty-five feet. The coal possesses the lustre, fracture, and other external characters of bituminous coal of good quality, notwithstanding that the shale which overlies it is rich in fossil remains of a flora of the Miocene period. The coal cakes when heated, and leaves sixty-one per cent. of a coherent coke. Its specific gravity is 1·3. The following are the results of my analysis, every precaution having been taken to insure that the sample analyzed was a fair average of the entire specimen :—

Carbon,	75·49
Hydrogen,	5·60
Oxygen and Nitrogen,	9·89
Sulphur,*	0·52
Ash,	6·49
Water,	2·01
	100·00

The composition of the coal, excluding water, sulphur, and ash, is :—

Carbon,	82·97
Hydrogen,	6·16
Oxygen and Nitrogen,	10·87
	100·00

* Including Sulphur in the form of iron pyrites, 0·36 per cent.

I have analyzed the ash and found that it consists of:—

Silica,	34·69
Alumina,	27·30
Iron Sesquioxide,	6·72
Lime,	7·79
Magnesia,	1·83
Potash,	7·58
Soda,	0·10
Sulphuric Anhydride,	13·79
Phosphoric Anhydride,	trace
Chlorine,	trace
	99·80

The quantity of potash in the ash is unusually large. On comparing the composition of the coal with that of other coals of various geological ages it will be found that the Arctic coal most closely resembles those of the true carboniferous period. Coal from the great seam in the Bay of Fundy, Nova Scotia,* possesses a chemical composition almost identical with that of the Arctic coal. On the other hand some lignites of the Miocene period bear a close chemical resemblance to the Arctic coal, if the composition, exclusive of water, sulphur, and ash, be compared. For example, a lignite from the Island of Sardinia possesses the following composition† :—

Carbon,	82·26
Hydrogen,	6·52
Oxygen and Nitrogen,	11·22
	100·00

It has been shown by Zincken‡ that it is impossible to determine the geological age of coal from its chemical composition; of this fact the Arctic coal affords a good illustration.

* Percy's Metallurgy, Fuel, &c., p. 336.

† *Ibid.* 313.

‡ Die Physiographie der Braunkohle.

NOTES ON THE SKELETON OF AN ABORIGINAL AUSTRALIAN.

BY

A. MACALISTER, M.D.,

Professor of Comparative Anatomy, University of Dublin.

[Read November 19th, 1877.]

THE Museum of the Dublin University has recently received a fine skeleton of an aboriginal Australian, which is a valuable addition to its ethnological department. I am indebted to Dr. R. Tuthill Massy, of Brighton, for this interesting donation, and have made a careful series of measurements and observations on it, the results of which I have embodied in this paper.

The stature was small, 5′ 1½″, which is about the average for Australian natives; though I am informed by Dr. Johnston, of this city, who has had extensive experiences of these races, that in some tribes, much taller individuals are common; and that on one occasion he met with an encampment of natives on the Murray river, many of whom were six feet high. Such are, however, exceptional, for the general consensus of opinion is that "very few could be said to be tall and still fewer to be well made." (Collins' Account, p. 356.)

The skeleton is that of a male, known and employed as a messenger, and who had been known to travel seventy miles in a day. The proportions are as follows compared with the standard in Professor Humphry's Work :—

TABLE I.

	Height.	Spine.	Humerus.	Radius.	Femur.	Tibia.
Australian, .	1·00	–	·203	·151	·286	·226
Irishmen, .	1·00	·340	·194	·154	·270	·225
Negroes, .	1·00	·311	·195	·151	·274	·232
Bushmen, .	1·00	·314	·20	·153	·277	·2389
Bushwoman,	1·00	·333	·182	·131	·264	·2108

To represent more accurately the relationships of the *intermembral* lengths, I append the following three tables :—

TABLE II.

RELATIVE PROPORTION of FOREARM to HUMERUS in length.

	Humerus.	Forearm.
Australian, . .	1·00	·74
Bushman, . .	1·00	·80
Negro, . . .	1·00	·76
European, . .	1·00	·79

The decimal obtained in this table or *antebrachial index* is interesting, as it shows that this individual had a greater proportional length of forearm than the average of Europeans, a pithecoid character.

TABLE III.

RELATIVE PROPORTION of FEMUR to TIBIA.

	Femur.	Tibia.
Australian, . .	1·00	·80
European, . .	1·00	·85
Negro, . . .	1·00	·89
Bushman, . .	1·00	·78

From this table it appears that the *crural index* is rather shorter than usual.

TABLE IV.

RELATIVE PROPORTION of FOREARM and ARM to THIGH and LEG.

	Lower.	Upper.
Australian, . .	1·00	·69
Bushman, . .	1·00	·87
European, . .	1·00	·70

This *intermembral index* shows that in this Australian the proportion of the arm to the leg is smaller even than the European.

The three methods of measurement adopted above are, I think, calculated to give us more definite results as to the relative regional developments of extremities than any other plans hitherto used. With many of the most interesting aboriginal tribes it is impossible to get whole skeletons, and when got, the spinal unit, so important a factor in Professor Humphry's whole number, is rather a vague one, on account of the varying thicknesses of intervertebral substance, unless the observer has obtained the skeleton while fresh. Limb bones, on the other hand, are easily obtained, and by a series of measurements like those given above and carried out on an extensive scale, we can easily formulate in the simplest possible manner, the relative developments of

the portions of the limbs. One set, like that given here, tells us comparatively little of ethnological importance, as the original may have been a Rob Roy among his tribe, or else *brachybrachial*, but an extensive series of such measurements would, doubtless, be of value.

The vertebral column showed no appearances of note. The third cervical had a trifid spine, as is not uncommonly the case. The spine of the sixth cervical was bifid, and the transverse process of the seventh perforated at each side. The sacral laminæ were mesially ununited, and the spinal curvatures were smaller than usual. The sacrum measured 3¾ inches in length, and 4·6 inches in breadth, the average male European sacrum being 3·9 inches by 5 inches.

The os innominatum is small, not unduly elongated, with no pre-auricular groove (Zaaijer), but with well-marked muscular impressions. The thigh bone has a small carina, and its neck forms a large angle (123°) with the shaft. The anterior intertrochanteric and the ectogluteal ridges are strong and rough.

The tibia has a tuberous external condyloid eminence for the attachment of the ligamentum iliotibiale (Maissiat and Merkel), a structure which I have always found to be of proportional strength in all persons, with great powers of endurance in their legs.

The skull presents the usual Australian dolichocephaly, and is of the usual small size, with narrow frontal region. The sutures are open and are comparatively simple, the lachrymo-planal being reduced to a very short space 0·2″ in length. There is a distinct double temporal crest (Hyrtl.), a double supra-orbital hole on the right side, the inner opening being for the supra-trochlear nerve. The spheno-parietal suture measures 0·4″ on the left, 0·35″ on the right. The occiput has two rough splenial ridges and a short fissure exists behind each. The tympanic is separated from the periotic by a distinct deficiency, and the post-glenoid process is separated from the tympanic bone by a fissure continuous with the glaserian. A strong supra-mastoid ridge exists, and strong stylohyals; a narrow transverse glenoid cavity, and a vertical anterior edge of the squamosal. The spine of the sphenoid has a double styloid process, one external and one internal to the foramen spinosum. The left lachrymal bone has an inferior hamulus, and the chin process is small.

A FRAGMENT OF HUMAN SKELETON FROM NORTH LATITUDE 81° 42′.

BY

DR. EDWARD L. MOSS.
Late Surgeon H.M.S. *Alert*.

[Read November 19, 1877.]

At the time the Arctic Expedition of 1875, left England, all that was known of the migrations of the Eskimo appeared to warrant the hope expressed in the manual supplied to the expedition by the Royal Geographical Society that Ethnological results of interest might be obtained. That hope was based upon the consideration that the route chosen for the expedition lay through an altogether exceptional region, exceptional in that it afforded the only ascertained gap in the northern frontier line bounding the geographical distribution of man.

In every other part of the circumpolar regions expeditions had penetrated either to lands, such as Spitzbergen or Franz Joseph Land, that bore no trace of an indigenous people, or to a barrier of eastward drifting perennial floes, impassable alike by Eskimo or European, and which if their full import had been appreciated might have saved much speculation as to the possibility of an inhabited Polynia in the middle of the Polar ice-cap.

But on the eastern side of the Parry group, and along both shores of Greenland, land spread continuously to the northward, and though each successive explorer had forced his way to a latitude never before reached on land, all had been obliged to confess that at their turning point the foot-prints of their uncivilized predecessors still lead Poleward.

When our ships started, the most northern known traces of man, were those found by Dr. Bessels, of the U.S.S. *Polaris*, at Cape Lupton. There, within a day's march of the furthest point on land reached by his expedition, rings of stones that had been used to fasten down the edges of tents, marked the temporary camp of some travelling Eskimo.

It was from this latitude that our continuous search along the coast-lines began. South of this point our visits to the shore on both the outward and homeward voyages were of the most flying character. Every movement of the ice had to be taken advantage of, and our naturalists had often less than twenty minutes to bundle together their specimens, Botanical, Zoological, and Geological; and yet abundant evidences of man were found on every beach, till Lady Franklin Sound intersected the coast-line. The *Discovery* wintered in a bay inside Bellot Island, on the north shore of Lady Franklin Sound, and in the same latitude as Cape Lupton, and the shores to the north instead of being merely visited at intervals, were traversed over and over again by our sledge parties.

Lady Franklin Sound had not interrupted the onward passage of the Eskimo. Tempted doubtless by the reindeer and musk-oxen, on Bellot Island and the neighbouring main-land, their hunters had crossed the sound, and several hearths, where splinters of burnt drift wood and bits of scorched bone lay amongst the blackened stones, where found on a long low spit of Bellot Island. On a little rocky island within a stone's throw of the main-land similar marks of summer hunting parties were discovered. For seventeen miles to the north-eastward the shore still affords a practicable path; but at Cape Beechey, the steep cliffs of Robeson Channel rise abruptly from the tumbling stream of Polar ice, that pours through the strait, under these cliffs and at the very end of the practicable coast, Captain Feilden discovered a broken sledge and a broken lamp. From this point northward our sledges followed the coast for 100 miles to the north-east, and for 250 miles to the north-west and found no further trace.

All the likely parts of the coast were traversed dozens of times both before and after the disappearance of the snow, and no spot where Eskimo had ever camped or cooked could possibly have escaped us. I feel quite confident that all who have travelled over the respective coasts will indorse the opinion already published by Captain Feilden,* that "the men whose tracks we followed to the 82° parallel never got round Cape Union, and that it is impossible for any Eskimo to have rounded the northern shores of Greenland."

* "Naturalist," Aug. and Sept., 1877.

The frontier line of known migration is therefore complete. Henceforward any hypothesis that inhabited lands exist in the unknown North must be based only on the vague traditions of the tribes on both sides of Behring Strait that emigrants from their shores have reached Kellett's Land.

But the traces we have hitherto spoken of do not include any vestige of man himself.

Even at Norman Lockyer Island, where we found the remains of a whole city of not only tent circles but "yourts," meant for winter habitations, we failed after hours of careful search to find anything like a burial place. When Captain Feilden discovered the lamp and sledge, the way in which the lamp was broken—so like the broken vessels left on the Indian graves of the far west—and the valuable pieces of wood that had been left lying beside it suggested the possibility at least that they had been left for the future use of their buried owner, but I could find no heap of stones or anything else like a tomb in the neighbourhood.

But seventeen miles backward, along the coast on the northern shore of Lady Franklin Strait, and at the most southern point overlooking Kennedy Channel, the fragment of human femur which I exhibit this evening was picked up. I am not aware that any human bone has been found in a higher latitude than the Etah burial-ground at Port Foulke, and this fragment lay 200 miles beyond that spot. The spot where it was found was eighty feet above the beach, and 100 yards inland, opposite the spit of Bellot Island, and about three-quarters of a mile eastward from the marks of camps on "Dutch" Island—the rock already spoken of. It was embedded in the side of one of those little polygonal hillocks into which the frost splits clayey ground. Both ends of the bone are broken off, the one through the neck and trochanters, the other about two inches and a quarter from the lowest point of the articulating surface. It has been gnawed by either wolf or fox, though I think the jaws of the little arctic fox are hardly strong enough to break the ends off so strong a bone. Like every other trace of man found at high latitudes in Smith's Sound it is very old; the tongue adheres to its surface, it is spotted with lichen, and a moss has found root in the cancellous structure of its upper end. The fragment measures eleven

and a half inches in length, and by comparing it with femora from old Eskimo graves on an island near Egedesminde, I estimate its restored length at sixteen inches. When its front is placed on a level surface the antero-posterior curve deviates a quarter of an inch from the horizontal at either end. As may be seen from the annexed section it is as carinate as most platycnemic femora. There are two nutritious foramina three and three-quarters and three inches below the lesser trochanter. Its minimum circumference is three inches below the lesser trochanter, and measures 3·43 inches. This with the estimated length gives a perimetral index of ·214.

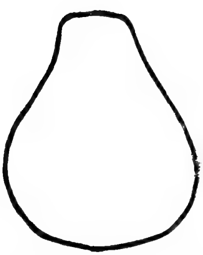
If its index were taken at the English average, *i.e.*, ·194, its restored length would be 17·68 inches, but the bone is evidently shorter than an average English femur, and the former estimate is probably the more accurate.

If Aeby's statement that races do not materially differ in the relative proportions of their limbs is correct, we may roughly estimate the stature of the man who owned this bone. The proportionate measurements of the skeleton given by Pruner Bey make the femur 27·29 in 100 of total height. Humphry's average is slightly greater, but calculating by either of them the man when living must have stood a little over 5 feet.

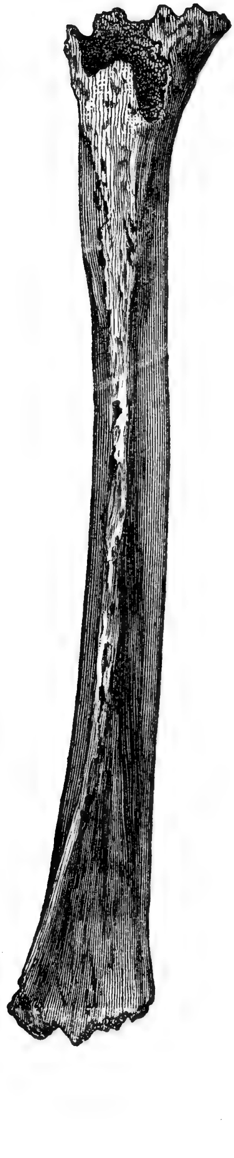
A careful search was made round the spot where this bone lay. The ground was very uneven. Some vertebræ and the skull of a young musk-ox were found within 200 yards.

It seemed probable that a longer search would have led to the discovery of some dilapidated cairn or cyst, for if the bone had been recent when first exposed to the attacks of carnvora, the medullary cavity would certainly have been broken into.

But no other vestige of man or trace of anything like a burial-place could be discovered before movements of the ice between our boat and the ship put a peremptory stop to our proceedings. The *Alert* and *Discovery* were then only waiting for an opening across the ice of Lady Franklin Strait to begin their return voyage, and our visit to the spot was never repeated.



Section through the centre of the Bone, natural size.



ON THE ELECTRIC TELEPHONE.

BY

W. F. BARRETT, F.R.S.E.

[Read November 19th, 1877.]

The following paper does not lay claim to any originality. It is simply a brief description of an instrument which will probably play an important part in the future of the human race; together with an historical note of what had been accomplished by Reis fifteen years ago.

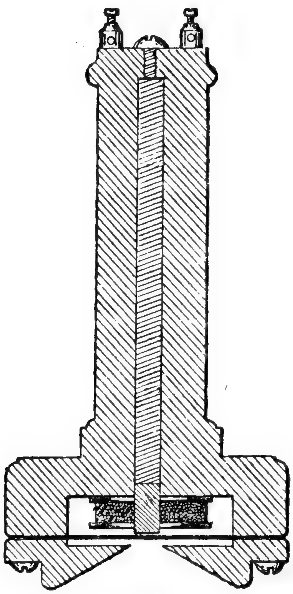
The various attempts to communicate audible speech by means of electricity have culminated in the recent discovery by Professor Graham Bell of the articulating telephone. The discovery was not the result of chance but of long and patient endeavour. Every sound of the human voice is communicated from the speaker to the listener by means of aerial vibrations of a definite character. For the same sound the same wave-form is always reproduced. Starting from this fundamental axiom, Professor Bell's first efforts were made with the view of visibly recording speech. A model of the human ear was constructed, to the tympanum of which a delicate style was attached, the movements of which recorded themselves on a moving slip of smoked glass. Thus the vowel sounds and a few simple words were readily recorded by this phonautograph; which, however, differed but little from similar instruments previously constructed. These experiments revealed to Professor Bell the important point that the transmission of speech by electricity could onlybe accomplished by using what may be termed an undulatory current: that is to say, one that merely varied in strength without the occurrence of any actual interruptions which would give rise to a discontinuous or intermittent current. It is this principle of an unbroken current which distinguishes Bell's telephone from all preceding efforts. The electric currents in this telephone are in simple proportion to the motions of the air produced by the voice, and further the electric waves sent to the distant extremity are (by a receiving arrangement precisely similar to the transmitting instrument), caused to reproduce motions of the air identically the same in character as those that gave birth to the currents. Thus not only is articulation heard perfectly, but moreover, the

different qualities of different voices are heard, so that at 50 or 100 miles distance the individuality of the speaker is transmitted as well as his ideas.

A section of the present form of this important instrument is shown in figure 1. A diagrammatic representation of the essential parts is given in figure 2: a permanent bar magnet (N.S.) (about four inches long), has a coil of fine wire (b) wound at one extremity, in front of the coil a disc (a) of thin sheet iron is fixed. The transmitting and receiving instruments are precisely alike, and no further source of electricity is required than that produced by

FIG. 1.

Section.



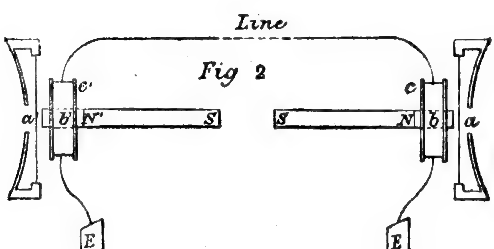


Fig 2

the to and fro motion of the iron disc. On speaking into the instrument vibrations of the disc are set up which give rise to magneto-electric currents in the coil of wire, one end of which is attached to the line wire. These electric pulsations produce corresponding changes in the intensity of the magnetic field at the receiving instrument, and hence give rise to motions of the iron disc analogous to those at the other end.

The extraordinary feature of this instrument is its extreme sensitiveness. The amplitude of the vibrations of the transmitting disc must be wonderfully small, and yet every inflexion of the voice is faithfully transmitted. At the receiving end the amplitude of the vibrations of the iron disc is so small as to be immeasurable, nevertheless not a syllable is lost, and in the larger instruments the voice is heard at a distance of some feet from the instrument.

The question arises, is the sound due to a molar or a molecular motion of the disc? Iron when magnetized and demagnetized gives rise to a peculiar click due to molecular changes, to which reference will be made in the sequel. No motion of the iron would be apparent in this case, but if the sound sprung from any motion of the disc as a whole, such as would arise from currents of sensible strength fluctuating through the coil beneath, then the motion of the disc might be capable of detection. Attaching a mirror to the disc and reflecting therefrom a ray of light, no motion of this reflected ray was visible on speaking through the instrument. Other arrangements were tried by the author of the present paper to test this question. A sensitive flame is an extremely delicate acoustic re-agent. Removing the wooden mouthpiece of the telephone, a small metal chamber was substituted, into this chamber coal gas at high pressure was sent, and burnt from an orifice furnished with a suitable jet. The gas thus traversed the iron disc within two inches of which it issued as a sensitive flame, so that any sensible motion of the disc would be detected by a disturbance of the flame. Although a flame of extreme sensitiveness was obtained, no effect was produced on the flame by any sounds shouted or hissed into the distant and electrically-joined telephone. These results confirm an experiment of Professor Bell's, who glued the iron disc to a thick block of wood, and in this way spoke through and heard by the telephone. Here any molar

motion would seem impossible. But if it be a molecular motion one would expect the sound to be of a peculiar quality, the molecular motions of solids having a crepitating character.

The solution of the difficulty seems to be this: Lord Rayleigh has shown (*Nature*, vol. 16, p. 114) that sonorous vibrations may be heard although the amplitude of the waves generating them be of transcendent smallness, an amplitude of one ten-millionth of a centimetre, Lord Rayleigh states is perfectly audible. Hence it is probable that the varied motions set up in the iron disc are motions of the disc as a whole, but of surpassing minuteness, and if so the telephone has directly confirmed Lord Rayleigh's deductions, and added to the wonders of our organs of hearing.

The greatest obstacle to the practical introduction of the telephone is at present the disturbing noises produced by induction from powerful battery currents traversing neighbouring wires. Apart from this it would appear that conversation can easily be carried on two or three hundred miles apart, and breathing has been heard by Professor Bell at 150 miles distance. By employing a return wire instead of an earth connexion much of the inductive disturbance can be neutralized. In the trials of the telephone at the Royal Dublin Society, a loud ticking was heard every second which much interfered with telephonic conversation. This ticking was not due to any neighbouring clocks, but was found to arise from the general electric clock system of the town. Instead of a return wire connexion was made with the gas-pipes of the building; this "earth" happened to be the same as is employed in the electric clocks, and hence the disturbance. Substituting a second wire the disturbance was removed.

Another obstacle at present before the telephone is the difficulty of its use in long submarine lines. This arises from the well-known cause termed "inductive embarrassment," the line with its insulating sheath and the sea around acting as a condenser, and thus preventing the rapid delivery of electric pulsations. Nevertheless, conversation has very successfully been carried on between Dover and Calais and Holyhead and Dublin. The mere *resistance* of a long line but little impedes telephonic conversation. The author of this paper has spoken with great ease through an actual line of some thirty miles, with an added resistance exceeding that of the Atlantic cable. The addition of the artificial

resistance simply renders the sound of the voice of the distant speaker fainter, as if he had gone further off, but in no way alters the quality of the sounds heard. Professor Bell has even spoken through a resistance of 60,000 ohms (the resistance of the Atlantic cable is equal to 7,000 ohms).

Various practical applications of the telephone at once suggest themselves. It is already largely in use in the United States for commercial purposes. It has been successfully tried in diving and mining operations in this country. In physical research it promises to be the starting point of new investigations, and as a delicate phonoscope, or sound test, it will doubtless be most useful both in the lecture-room and physical laboratory. The telephone also reveals the existence of very feeble electric currents by the audible vibration of its iron disc. So prompt and sensitive is it to the slightest fluctuation in the strength of the current traversing its coil that it is not unlikely it may be of use in searching out rapid and feeble variations in a current that may escape detection by a galvanometer, owing to the inertia of even a light magnetic needle. Information as to the duration and character of rapidly intermittent currents is needed in medical science and not improbably the telephone may be able to furnish this information, when associated with a chronograph.

The first attempt to transmit sounds by electricity is due to Philip Reis, teacher of natural history in a grammar school at Freidrichsdorf near Homburg. A brief reference to what Reis accomplished may here be of interest. I am indebted to Dr. Messel, a name well-known to chemists, who was a former pupil of Reis and eye-witness of his early experiments, for the following interesting letter on this subject:—

"Reis' first experiments date as far back as about 1852. But at that time ended in failure, and were not resumed as far as I know till 1860. The first publication about Reis' telephone appeared in a daily paper of Frankfort-on-Main, which however I have not succeeded in procuring. Reis gave his first public lecture on October 26th, 1861, when he showed his telephone before the Physikalische Verein (Physical Society) of Frankfort-on-Main, and I send you herewith a copy of his paper.

"The original telephone was of a most primitive nature. The transmitting instrument was a bung of a beer barrel hollowed out, and a cone formed in this way was closed with the skin of a German sausage which did service as a membrane. To this was fixed with a drop of sealing

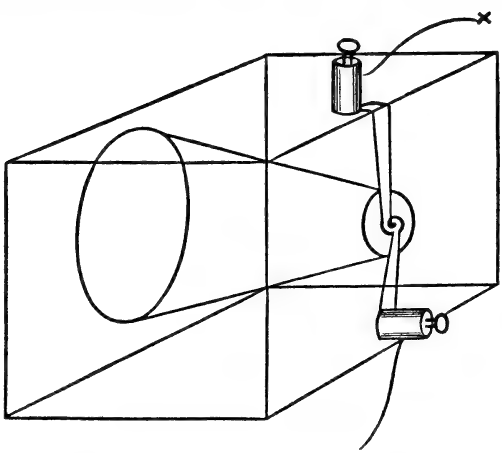
wax a little strip of platinum, corresponding to the hammer of the ear, and which closed or opened the electric circuit, precisely as in the instruments of a later date. The receiving instrument was a knitting needle surrounded with a coil of wire and placed on a violin to serve as a sounding board. It astonished everyone quite as much as the more perfect instruments of Bell now do.

"The instrument I have described has now passed into the hands of the Telegraph Department of the German Government."

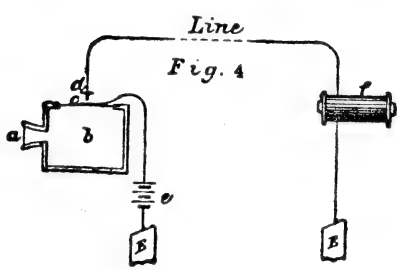
The paper referred to in the foregoing letter is contained in the annual report of the Physical Society of Frankfort-on-Main for the year 1861. It is entitled "Telephony by means of electric currents" for the word *telephone* is first suggested by Reis in this paper as the name of his instrument. The transmitter is shown in fig. 3, instead of a cork a cubical wooden block is used with a conical orifice closed at the smaller end by a membrane.

The accompanying diagram, fig. 4, shows the principle of Reis's

FIG. 3.



Reis's early form of Transmitter.

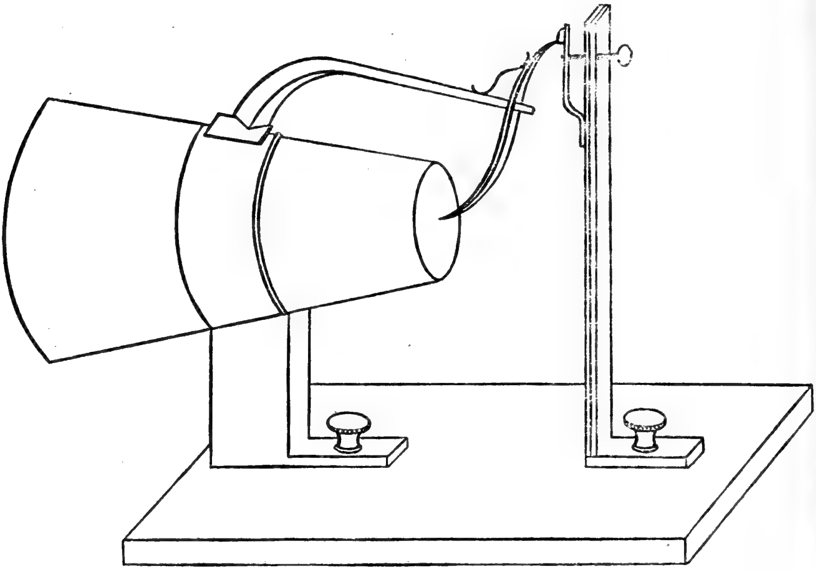


telephone; *b* is a box or small resonant cavity into which the operator sings through the mouthpiece *a*; a diaphragm of bladder or paper *c* covers the upper part of the box. This is thrown into vibration by the voice, and comes into contact with the platinum point *d*. The centre of the diaphragm is furnished with a fragment of platinum foil whereby contact is made and broken with the battery *e*. The *intermittent* currents thus transmitted through the line arrive at the receiver *f*, which is simply a straight iron wire, surrounded by the coil through which the current passes. The rapid magnetizations and demagnetizations of the iron wire by the current give rise to a musical note emitted by the iron, the pitch of the note corresponding to that sung into the receiver.

The discovery that a sound was produced in iron by magnetization is due to an American page in 1837. It was explained by De la Rive, of Geneva, in 1843, who showed that it was caused by the slight elongation of the iron which accompanies the act of magnetization, a fact discovered by Joule in 1842. The author of this paper has found that the magnetic metals nickel and cobalt also yield a corresponding sound on magnetization: with cobalt the note is clearer and more metallic. The author has also corroborated the fact noticed by De la Rive, that stretching the iron wire diminishes the sound, because it diminishes the elongation by magnetization, and further at a certain tension the sound ceases, the elongation here ceasing. At a still greater tension iron *shortens* by magnetization, and the author has found that here too, as we might expect, the sound again is produced, and shortly before the breaking strain of the wire is reached the loudness of the "magnetic tick" is almost as great as with the unstretched wire. By attaching the iron wire, surrounded by its coil, to a monochord, and using a rapidly interrupted current, the rise and fall and extinction of the sounds by varying the tension of the wire can be easily heard throughout a very large theatre.

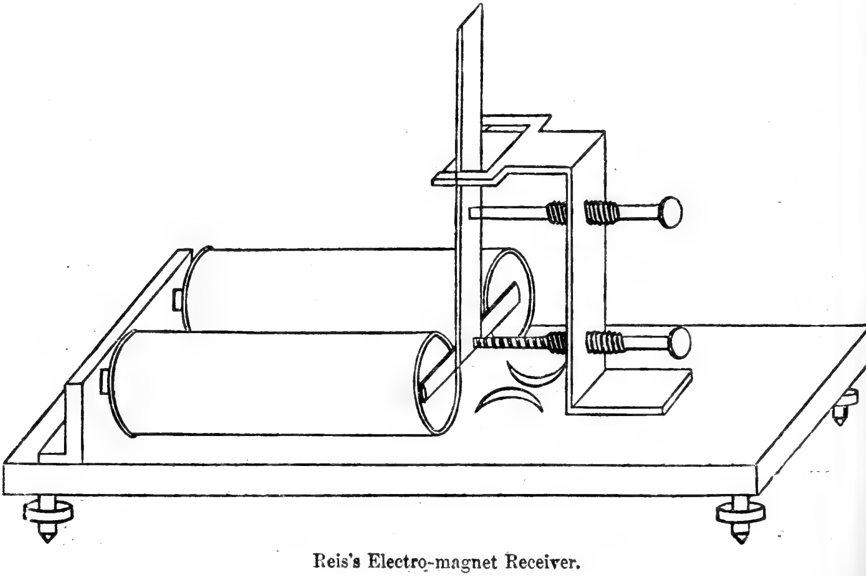
After his first success Reis improved both his transmitting and receiving instruments. In a report on Reis's telephone by Legat, Inspector of Telegraphs in Cassel, &c., published in 1862 in the journal of the East-German Telegraph Company and reprinted

FIG. 5.



Reis's improved Transmitter.

FIG. 6.



Reis's Electro-magnet Receiver.

in 1863 in Dingler's Polytechnisches journal Vol. 169, p. 29, the following sentence occurs. "Melodies can be reproduced with astonishing certainty, whilst single words, in reading speaking, &c., were less distinct, although the peculiar modulations of the voice in speaking, calling, interrogation, surprise or command were clearly marked."

The instrument described in this report is somewhat different from the earlier form. The diaphragm was a collodion film and the contact-breaker behind it was lighter and constructed in form of an S shaped lever, the longer arm of which was in contact with the membrane while the shorter made and broke the circuit (Fig 5.) There was no metal disc on the membrane but the circuit was completed by means of the arm on which the lever delicately moved. The receiver, moreover, was a small horse shoe electro-magnet, fixed horizontally to a sounding-board. (Fig. 6.) Here the movement of a light keeper adjusted by a spring before the poles of the magnet reproduced the original sounds.

In a paper on Reis's improved telephone published in *Böttgers Polytechnisches Notizblatt* No. 15, 1863, it is stated "Particularly distinct was the reproduction of the scale. The experimenters could even communicate to each other words; only such however as they had already heard frequently." In confirmation of this may be added the following extract from a recent letter of Dr. Messel to the present writer. "There is not a shadow of doubt about Reis having achieved imperfect articulation, I personally, remember this very distinctly and could find you many other ear-witnesses of the same fact."

In 1865 a modification in Reis' transmitter was made by Mr. Yeates of Dublin which might have led to important results had it been followed up at the time. A drop of water was introduced between the contact breaker of the transmitter. By this means the current was to some extent rendered a *continuous* one, the essential feature in a perfect articulating telephone, where gradual variations of the current strength are necessary and not sudden interruptions. Mr. Yeates also independently adopted the electro-magnet form of receiver that Reis had introduced in his later form of telephone. The instrument as modified by Mr. Yeates was shown at a meeting of the Philosophical Society in Dublin in 1865 and the articulation of several words was distinctly heard. But even in this and in

Reis's latest form of telephone there is no comparison between the feeble attempts at articulation and the almost perfect articulation that is obtainable in Professor Graham Bell's simple and beautiful instrument: *almost* perfect, but not quite, for there is a peculiarity in the sibilants which render them extremely difficult of transmission, the letter S sounds as F to the listener at the receiving instrument and M sounds as P; so that *whim* becomes *whip* or even *hip: strength* turns into something like *creap* or *creace*, &c.

In Professor Bell's telephone the voice itself generates magneto-electric currents and hence the reproduced sounds are very faint and slight electric disturbances are frequently fatal to the effective working of this instrument. The telephone of the future will doubtless employ the voice of the speaker to modulate the strength of an electric current generated by independent means. Hence the discovery of a more perfect and pliable means of varying the resistance in a circuit by the act of speaking is one of the chief objects to be attained at present in the new art of electric-telephony.

NOTE ON THE SPHEROIDAL STATE.

BY]

W. F. BARRETT, F.R.S.E.

[Read December 17th, 1877.]

AT the last meeting of this Society, Mr G. Johnstone Stoney gave a new and beautiful explanation of the so-called spheroidal state of liquids, wherein he showed that the force detected by Mr. Crookes, and which is the cause of the motion of radiometers, was also competent to explain the phenomena of the spheroidal state. A liquid drop is said to be in the spheroidal state when falling upon a hot body it does not come into contact with the surface but rolls over it as a flattened spheroid. A mobile elastic spring evidently buoys up the drop until such times as the hot body cools, when, with a sudden rise of temperature and generation of steam, the drop comes into contact with the surface below it, spreads out into a film, and rapidly disappears into vapour.

Hitherto this phenomenon has been regarded as due to the fact that the proximity of the hot surface converts a portion of the liquid into vapour, the elastic force of which sustains the drop. There are, however, several phenomena, allied to the spheroidal condition, to which this generally received explanation gives no solution. Such, for example, as the mobility of light powders in a hot crucible, or the formation of globules on the surface of water and other liquids. Mr. Stoney's explanation, on the other hand, embraces the whole of these outstanding and hitherto enigmatical phenomena. Briefly stated this theory is based on the fact that whenever two bodies at *different temperatures* are brought sufficiently near each other a modification takes place in the molecular structure of the layer of gas or vapour between them, giving rise to the so-called 'Crookes' force,' wherein there is an excess of pressure in the direction joining the hot and cold surfaces over the pressure in transverse directions. Now this excess of pressure depends partly on the quantity of heat making its way across the intervening layer of gas or

vapour, and partly on the proximity of the two surfaces. A proximity not to be estimated absolutely, but with reference to the length to which a molecule of the gas will travel in the intervals between its encounters with other molecules. Hence there are obviously three modes whereby the excess of pressure, this Crookes' force, may be developed or augmented :—

1st. By lengthening the paths of the molecules between the warm and cool surfaces, accomplished by attenuating the gas.

2nd. By bringing the hot and cold surfaces very near together.

3rd. By increasing the difference of temperature between the two surfaces.

Now if the support of the spheroidal drop be due to this Crookes' force a difference of temperature must exist between the drop and the surface over which it stands, and the greater this difference of temperature the larger the drop that ought to be supported, and the more persistent the phenomenon. Mr. Moss has shown (Proc. R. D. S., Dec. 1877) that by securing a continual difference of temperature a globule of ether may be supported on the surface of its own liquid for upwards of an hour, until in fact some accidental derangement occurs. The conditions of the two theories being thus defined, it is easy to see that several crucial experiments might be devised which should help to decide the question at issue.

The following experiment the author has made with this object in view. Upon the surface of the ordinary petroleum of commerce, liquid globules of transient duration can readily be formed, simply by removing a small quantity of the liquid in a pipette and carefully depositing a drop on the surface of the liquid. These drops are clearly in the spheroidal condition, and they are easily and abundantly formed by dipping a vibrating tuning fork into the liquid, or by drawing a fiddle bow over the edge of the vessel containing the liquid. According to the ordinary explanation the drops are supported by the elastic force of the vapour of the liquid, which would, of course, be greater the higher the temperature of both liquid and drops. According to Mr. Stoney's theory the drops are supported by the Crookes' force, generated by the proximity of the drop and liquid, and by the fact that they are at different temperatures. Evaporation rapidly cools the drops jerked up from the liquid, and thus a slight difference of tempera-

ture instantly comes into play. If, however, Mr. Stoney's theory be true, then a drop of cool petroleum would be more easily and longer sustained on a surface of warm petroleum, or *vice versâ*, than a drop taken from the mass of liquid below it, where only a slight temperature difference is created.

Two beakers were filled with petroleum from a common source, one (A) at the temperature of the air, the other (B) at a temperature of 100° F. With a pipette some liquid was taken up from A and a drop carefully deposited on its own surface, a globule was formed, floated for a fraction of a second and then disappeared. The same occurred with a drop from B placed upon B. A drop of B was now removed and deposited on A, a large globule was easily formed on the surface, floated about from 10 to 20 seconds and then disappeared. A drop of A was now placed on B, the same thing occurred, but the duration of the drop was not quite so great, owing to the greater density of the cool drop tending to sink it below the surface of the warm liquid, thus rupturing the Crookes' layer and destroying the difference of temperature.

There is no doubt or uncertainty whatever about this experiment, and it shows that, if the ordinary explanation be correct the second case, where B rests on B, should give the best result, whereas the reverse is the case. Further, the experiment wherein the best result is obtained, is such as best fulfils the condition of Mr. Stoney's theory.

The limit of formation of these spheroids, when the liquid is uniformly dropped through a gradually increasing height, may be employed to test the relative degrees of force which sustain the globule, and careful experiments made by the author in this direction still further corroborated the truth of Mr. Stoney's views.

ON THE SPHEROIDAL STATE.

BY

RICHARD J. MOSS, F.C.S.

(Read December 17, 1877.)

IN a paper on "The Penetration of Heat across Layers of Gas" read at a recent meeting of the Society, Mr. Stoney* includes Leidenfrost's phenomenon, or as M. Boutigny† calls it, the spheroidal state of volatile liquids, as an instance of the action of the peculiar form of pressure which is exerted between hot and cold surfaces when they are within a certain distance from one another, depending on the length of the free path of the molecules of the gas enclosed between the hot and the cold surfaces, and on the difference of temperature of these latter. This explanation of the spheroidal state places the phenomenon in an entirely new light. It has hitherto been supposed that a volatile liquid in this condition was sustained, and prevented from touching the adjacent hot body by a rapid disengagement of vapour from its surface. The explanation that was generally accepted is very clearly expressed by Dr. Tyndall in his "Heat as a mode of Motion," p. 154, where, referring to a spheroid of water in a hot metallic basin, he says :—"The drop rolls about on its own vapour—that is to say, it is sustained by the recoil of the molecular projectiles discharged from its under surface. I withdraw the lamp, and allow the basin to cool, until it is no longer able to produce vapour strong enough to support the drop. The liquid then touches the metal; the instant it does so violent ebullition sets in."

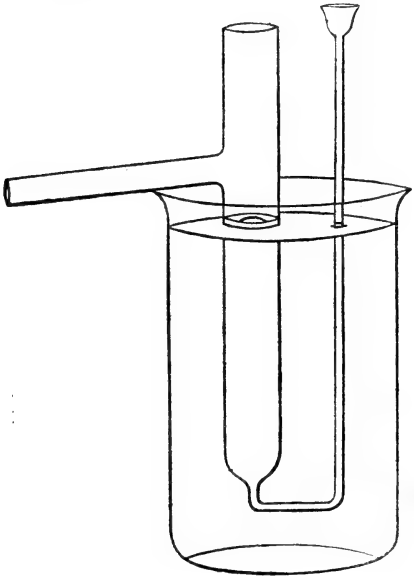
It has, however, been regarded as a remarkable circumstance that a quantity of vapour sufficient to produce the effect could be given off by the liquid under the circumstances, for, as M. Boutigny has shown, the spheroidal drop is always at a temperature below its boiling point, a condition that is not favourable

* Transactions of the Royal Dublin Society, vol. 1 (new series), p. 13.

† Proceedings of the Royal Institution of Great Britain, vol. 1, p. 179.

to the maximum production of vapour. Mr. Stoney's explanation not only removes this anomaly, but demands the comparatively low temperature of the spheroid as an essential condition of the phenomenon, since the existence of the layer of polarized air or vapour by which the spheroid is supported, requires the proximity of a cool surface, in order that the velocity of the gaseous molcules moving from this surface may be much less than that of the molcules which move towards it from the adjacent hot surface.

Mr. Stoney suggested to me the possibility of maintaining spheroids on liquid surfaces of the same substance by ensuring that the floating drop shall continue cooler than the liquid underneath, and by otherwise removing the causes which occasion its shipwreck. Commercial ether readily adapts itself to the required conditions. After a series of experiments I have adopted the arrangement shown in the figure as one which successfully accomplishes the desired objects.



A thin glass tube about 15 mm. in diameter and 12 cm. long having a spout-like limb about 7 mm. in diameter and 7 cm. in

length attached 4 cm. from one end, is contracted at the other end, and attached to a narrow tube bent twice at right angles, so that the two tubes are parallel. The narrow tube terminates in a small funnel. This apparatus, held vertically in a clip, is immersed in a beaker of water, so that the surface of the water is about a centimetre below the attached end of the spout-like limb, the other end of which extends beyond the edge of the beaker. By means of the funnel ether is poured into the narrow tube until it rises in the larger tube to the level of the water in the beaker, or a millimetre or two above it. The beaker stands on an iron plate which can be heated in any convenient way until the temperature of the water in which a thermometer is placed reaches 30°-32° C. If a narrow pippette with a very small opening be now immersed to the depth of 1 or 2 cm. in the ether in the large tube and quickly withdrawn to a short distance, the drops which fall from it being rapidly cooled by evaporation, readily assume the spheroidal state, and often continue to float on the warm ether for a long time. The evaporation from the spheroid is so very slight that some time must elapse before any alteration in its size can be detected. On the other hand, the warm ether on which the spheroid floats evaporates very quickly, and its heavy vapour flows out through the spout at the side mixed with air which is drawn in at the mouth of the large tube. This cool air passing over the surface of the spheroid enables it to part with the heat which it is constantly receiving from the warm ether by radiation, by the passage of heat through the Crookes's layer on which it is supported, and by the precipitation of ether vapour. The ether lost by evaporation is replaced from time to time by pouring ether in at the funnel. By means of this arrangement I have kept a spheroid about 5 mm. in its longest diameter, floating for more than an hour and a half.

In the progress of this experiment the sustaining medium becomes ether vapour alone; it may, however, be experimentally demonstrated that the presence of a gaseous medium other than that derived from evaporation produces the same effect. For this purpose it is desirable that the substance employed should not be very volatile. It is also important that it should be specifically light, as the heavier the spheroid the more

force has to be exerted to keep it afloat, or in other words, the greater must be the disparity of the velocities of the molecules of the intervening medium; and to produce this disparity there must be a considerable difference of temperature between the spheroid and the liquid on which it floats. In the case of light liquids there is less force to be exerted, and therefore a slight difference of temperature suffices. I find melted paraffin supplies all the requirements of the case. It is light, its sp. gr. at 15° c, being 0·86, while in the liquid state it is much lighter. On placing ordinary paraffin in a shallow silver basin and melting it I found that drops in the spheroidal state were easily obtained at temperatures not greatly exceeding the melting point of the paraffin. They are very easily obtained at 80°–90° C, and by directing a current of cool air over the surface of the liquid they may be kept in existence for a considerable time. I have kept them afloat for more than twenty minutes without any special attention to the temperature of the paraffin or the strength of the current of air employed to keep the drops cool, and I have no doubt that with care their existence might be indefinitely prolonged. I have devised a method for performing the experiment in a closed flask in which any gas may be contained, and at any desired tension; my experiments with this apparatus are, however, not yet completed.

For the purpose of ascertaining whether there was any appreciable evaporation from melted paraffin at a temperature favourable to the existence of spheroids, I placed three porcelain capsules containing paraffin on an iron plate, and heated them until a thermometer placed in one of them rose to 90° C. One of the capsules was then allowed to cool, and weighed, after which it was replaced on the hot plate and kept there for two hours, during which time I occasionally produced spheroids on the paraffin in the third capsule, some of these lasting a considerable time. When the weighed capsule was allowed to cool and again weighed I found a very slight increase had taken place. On repeating the experiment twice similar results were obtained. I therefore decided upon performing the experiment *in vacuo* for which purpose 5·5 grammes of the paraffin that had been repeatedly heated in one of the capsules was transferred to a small flask which was attached to an air pump and exhausted.

The paraffin was melted by immersing the flask in boiling water. After half an hour the flask was allowed to cool *in vacuo* and weighed. This operation was now repeated, the paraffin being heated for an hour by enclosing the entire flask and part of the tube communicating with the pump in a metallic vessel which was immersed in boiling water. The paraffin having been allowed to cool *in vacuo* was found on again weighing the flask to be precisely the same weight as it was originally. I could have detected a loss of 0·00005 gramme or $\frac{1}{110000}$ of the weight of the paraffin if it had taken place, and considering that the temperature employed was 10–20° higher than that at which spheroids of paraffin are readily produced, I think one may reasonably conclude that paraffin is not appreciably volatilized at a temperature which admits of the existence of a spheroid on its surface. And since the spheroid must in this case be at a lower temperature than the liquid on which it floats, it is even less likely to produce vapour sufficient to keep it floating. In confirmation of this conclusion I may mention that I have been unable to detect the slightest diminution in the size of paraffin spheroids, though I was occasionally much puzzled by the appearance of small spheroids in the place of large ones which I had left floating a short time before, until I detected one of these large drops disappearing with a slight splash which called into existence a new spheroid much smaller than its predecessor. These experiments in all their details are in accordance with Mr. Stoney's explanation of the phenomenon, and they demonstrate that the previously accepted theory is untenable.

It is noteworthy that in 1874 Mr. Crookes* suggested that "The phenomenon of the spheroidal state is probably due in some measure to a repulsive force exerted between closely approximated bodies, one of which is at a very high temperature." And although the true nature of "the repulsive action of radiation," to which Mr. Crookes considered the phenomenon attributable was at this time unknown, he ventured to anticipate "that a condition similar to the spheroidal state will be found to obtain between non-volatile bodies."

* Philosophical Transactions of the Royal Society of London, vol. clxiv., part 2.

NOTE ON THE MICROSCOPIC STRUCTURE OF THE SCALE OF *AMIA CALVA*.

BY

H. W. MACKINTOSH, B.A.,
Senior Moderator in Natural Science, Trinity College, Dublin.

[Read December 17th, 1877.]

ABOUT four years ago Professor Macalister, Director of the Museum of Comparative Anatomy and Zoology in the University of Dublin, obtained a fine specimen of the North American Ganoid *Amia calva*, and before sealing it up and placing it in the Museum, kindly gave me one of the scales for microscopic examination. Pressure of other matters prevented me at the time from bestowing upon it more than a cursory glance, and it has lain mounted in my cabinet almost forgotten till a few months ago, when, having occasion to demonstrate some points in the structure of the scales of fishes, I was led to give it a more careful study, which brought to my notice a peculiar form of lacunæ which does not seem to have been hitherto described, and which may be of interest to the members of this Society.

Amia is commonly described as a ganoid with overlapping cycloid scales. I submit that in the face of figs. 1 and 2, the term cycloid must be abandoned and replaced by ctenoid. The mistake has probably arisen from the fact that the teeth on the free edge are too fine to be noticed by the unaided eye, whilst the ridges of which the teeth are the terminations give a circularly striated appearance to the whole scale, a deception which is aided by the deposit of thickening layers on the proximal parts of the scale, leaving thinner and therefore more transparent spaces between them. In reality the ridges run in a sinuously longitudinal direction, with a certain tendency to confluence along a line (*a*, *b*, fig. 1) transverse to the scale, and placed at a short distance from its fixed (anterior) edge. They are apparently compound, separated from each other by a very

narrow groove (*a, a, a*, fig. 2), and bearing on their upper surface a broad flat elevation, the middle of which is again raised up into a sharp narrow ridge. The lacunæ whose form I wish specially to call attention to are grouped together in the middle line near the anterior edge of the scale, and appear as minute black dots visible to the unassisted eye on careful scrutiny. They are placed immediately beneath the superficial layer of ganoin which clothes the whole surface of the scale, and apparently makes up the entire of the posterior thin part, which is altogether devoid of lacunæ of any sort. When examined under a low power (180 diams.) they are seen (fig. 3) to consist of a central axis which for the most part has a decidedly fusiform shape, but which sometimes (*a*, fig. 3) is simply linear. From this central axis arise a number of very short canaliculi, which are mostly linear and end abruptly, but sometimes taper rapidly to a very fine point. Starting from these, in some cases, and superposed on them in others, are other canaliculi, which lying thickly together often give the lacuna to which they belong a wonderfully confused appearance (*b*, fig. 3), and may even render it a matter of some difficulty to trace the central axis. It must be understood, however, that in many cases like *b*, fig. 3, the apparent canaliculi are really small independent lacunæ, not connected at all with the central lacuna but merely overlying it. As a rule there is not much tendency to communication amongst the different lacunæ; sometimes (*c, d*, fig. 3) we find a small lacuna or a system of them in slight connexion with a larger one, though I have not been able to satisfy myself that this is always a true anastomotic union. Employing a higher power (260 diams., fig. 4) we bring out more clearly the fusiform shape of the main lacuna, and the usually abrupt termination of the canaliculi. Very often (*d*, fig. 3; *a, b*, fig. 4) these are placed with singular regularity, forming a series of crosses with the points of intersection at the lacuna, giving the entire system an appearance which is unique so far as I can ascertain. These are the only lacunæ found at the centre of the scale, but as we go out towards the margin we find others making their appearance, more in accordance with the usual form. Thus in fig. 4, which represents a group occurring in the same field of view, whilst *a, b*, and *c* are eminently

characteristic and unlike ordinary lacunæ, *d* with its elongate and more tapering form and fewer canaliculi is assuming a more normal appearance, and *e* is still more normal, having altogether lost its short abrupt lateral branches, and only presenting very fine and tapering terminal ones. At the margin of the scale we find lacunæ of this kind alone (fig. 5), differing from each other only in respect of their length, number and extent of canaliculi, &c., and reminding us of the well known lacunæ of the allied *Lepidosteus osseus* (fig. 6) which are figured in most books on microscopy. They differ from them, however, in being much larger, less globular, and having much wider canaliculi which do not anastomose to the same extent; whilst the scale itself does not exhibit any of the canals running in from the surface which seem to be constant in the scales of Lepidosteus. There do not appear to be any lacunæ in the posterior part of the scale from about *c d* backwards, in front of this line they begin as small simple forms like *e*, fig. 4, and *a*, fig. 5.

Explanation of the Plates.

Fig. 1. Entire scale of *Amia calva* magnified 5 diameters, showing the finely toothed posterior edge, the general direction of the ridges, and the position of the characteristic lacunæ. The line *a b* indicates the place where the ridges tend to run into each other, *c d* the level behind which no lacunæ are found.

Fig. 2. A portion of the posterior part of the scale showing the nature of the ridges and the toothed border, $\times 90$. The arrows show the direction in which the light came, oblique illumination having been used.

Fig. 3. Lacunæ from the central part of the scale, $\times 180$. At *a* is seen one in which the central lacuna is linear; *b* is one of the highly complex forms; *c* and *d* have smaller lacunar systems connected with them.

Fig. 4. Lacunæ occurring in the same field of view, $\times 260$. Taken from a part of the scale about half way between the centre and the margin; *a*, *b*, *c*, are of the characteristic complex form, *d* and *e* are simple.

Fig. 5. Lacunæ from the marginal part of the scale, $\times 260$. At *a* is seen one of the simplest forms.

Fig. 6. Lacunæ from the scale of *Lepidosteus osseus*, $\times 260$ showing the small size of the lacunæ, their globular shape and very fine canaliculi.

The drawings were all made under a Wollaston camera lucida.

ON THE VARIOUS FORMS OF APPARATUS USED FOR POLISHING SPECULA FOR REFLECTING TELESCOPES.

BY

SAMUEL HUNTER, F.R.A.S.

[Read 17th December, 1877.]

WE owe the reflecting telescope to Sir Isaac Newton,* and the idea was presented to his mind through a remarkable mistake he made in believing that refracting telescopes as then made were incapable of further improvement. In a paper presented to the Royal Society in February, 1672, he writes :—" In the beginning of 1666 (at which time I applied myself to the grinding of optical glasses of other figures than spherical) I procured me a triangular prisme to try therewith the celebrated phenomenon of colours," which " was at first a very pleasing divertissement." Starting from this " divertissement" he found that the colours observed in the telescopes, as then constructed with object-glasses consisting of a single lens, were due to the nature of light. He writes—" When I understood this I left off my aforesaid glass works, for I saw that the perfection of telescopes was hitherto limited—not so much for want of glasses truly figured—as because that light itself is a heterogeneous mixture of differently refrangible rays; so that were a glass so exactly figured as to collect any one sort of rays into one point, it could not collect those also into the same point which, having the same incidence upon the same medium, are apt to suffer a different refraction." That is, he discovered that rays of light falling on a single lens at AA′ become decomposed into the colours of the spectrum on leaving it at B B′, the red rays coming to a focus at r, the violet at v, and the other colours at intermediate points. Sir Isaac failed† to discover that with different kinds of glass the distance vr, varies (*i.e.* their dispersion) and hence did not see that by combining glasses of

* Gregory described his form of reflecting telescope in 1663, and had one constructed in 1664, but failed in obtaining a satisfactory result.

† Query—Did this arise from his having used only one kind of glass in his prisms ?

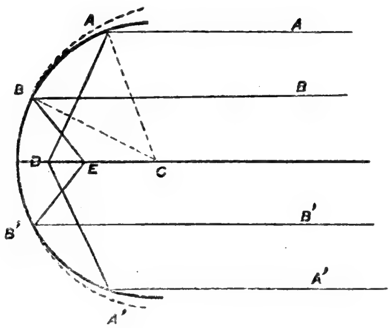


Fig. 1.

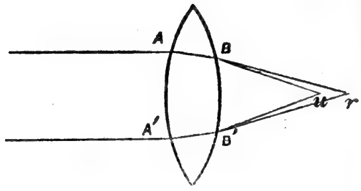


Fig. 2.

different dispersive powers an achromatic telescope could be formed.

"This made me," he writes, "take reflexions into consideration, and finding them regular, so that the angle of reflexion of all sorts of rays was equal to their angle of incidence, I understood that by their mediation optick instruments might be brought to any degree of perfection imaginable, provided [1] a reflecting substance which would polish as finely as glass, and [2] reflect as much light as glass transmits, and [3] the art of communicating to it a parabolic figure be also attained." Here Sir Isaac gives us the three requisites to a good reflecting telescope, but it is with the last alone we have to do at present.

Let us first see why the figure must be parabolic. Suppose the rays A and A′, B and B′ fall on a segment of a sphere, A and A′ being more remote from the axis than B and B′, C being the centre of curvature, Sir Isaac found that the angle of incidence AAC was equal the angle of reflection DAC. So also the angle BBC=EBC. Hence parallel rays falling on a true spherical surface come to a focus at different points, according to their distance from the axis of curvature DC. Now if the curve at A could be flattened a little, as indicated by the dotted line, it is clear that the angle of incidence, AAC, could be made=the angle EAC and all the rays would come to a focus at the same point E. The curve of which that holds good is called a parabola. The difference between these two curves

is so small that at the margin A of a telescope 4 feet in diameter and 40 feet focus, their distance apart is less than the $\frac{1}{21000}$ of an inch ($\frac{1}{21333}$). You will observe that the parabolic figure is best suited for parallel rays, such as come from the heavenly bodies; for viewing terrestrial objects the spherical form is just as good, and for near objects, much better.

After two years' interruption, caused by the Great Plague, Sir Isaac Newton, to use his own words, had then "thought on a tender way of polishing proper for metal," and set to work. After a time he succeeded in making the first reflecting telescope of thirteen inches radius, by which he was able to see Jupiter's four concomitants, as he calls them. And strange to say, since then we have simply been following in his track; he indicated the metals still used in the construction of the speculum, and the mode of operation we owe to him in a great measure; we have only improved in the details.

The production of a spherical surface is comparatively easy, for the mutual rubbing of two bodies naturally tends to produce that form, but it is otherwise with the parabolic.

We will first describe in detail the hand process of polishing specula used up to the time of Sir Wm. Herschel, who first constructed a machine for this purpose.

A tool made of iron, pewter, or some such material, was cast and turned to a radius of twice the intended focal length. Some had this tool of a greater diameter than the speculum, some of the same diameter; this was fastened on an upright post, with the face upwards, emery and water was applied, and the operator, holding the speculum by a wooden handle cemented to its back, walked round the post, pushing the speculum to and fro in straight, elliptic, or circular strokes, supplying emery from time to time, until every part of the speculum was acted on equally by the emery. The tool was then examined to see if the curvature had altered, if so it was turned again to the proper radius, and the grinding proceeded as before. When the speculum was equally acted on by the emery, and the tool found to be of the proper curve, finer emery was applied, and finally using only the sediment obtained from water in which flour of emery had been stirred up and allowed to stand for ten seconds, thirty seconds, and up to four minutes before being poured off.

If proper care were taken, the surface was now free from scratches, capable of reflecting a considerable amount of light, and of a spherical form. The polishing now commenced, the object of which is not only to make the surface reflect the greatest amount of light, but also to give the parabolic figure, and in this consists the great difficulty.

Speculum metal is very porous; a moderate magnifying power will show the surface full of little holes, so that if we used an elastic cushion of any kind to carry the polishing powder, the result would be that the powder would be forced into these pores, whose edges would be worn away, and the entire surface would thus be full of little pits, so that a true figure or good reflecting surface would be impossible.

On the other hand, if we used a hard unyielding substance, we could only produce a spherical surface, as it is by the mutual adaptation of the two surfaces that we are enabled to obtain the parabolic.

Fortunately, in pitch we have an almost inelastic body capable of adapting itself to any surface with which it is in contact, and yet being a solid. Ice is the only other solid that I know of which possesses this latter property. The tool used in grinding, or another made to the same curvature, usually a little larger than the speculum, was now covered with pitch to a depth varying from the thickness of a half-crown to half an inch; grooves were cut in this to allow it to expand equally in a lateral direction, and thus become more quickly adapted to the speculum. Some made the polisher smaller than the speculum, and others used an oval polisher.

The Rev. Mr. Edwardes, writing in 1787, recommends that the longest diameter be to the shortest as 10 : 9, the latter being equal to that of the speculum, and seems to be the first who used the oval polisher. Sir John Herschel speaks highly of the oval form, as also Messrs. Delarue and Nasmyth.

The consistency of the pitch should be such that a sovereign resting on its edge for one minute should leave clear impressions of three of the millings on its edge (Lassell's test); if softer than this it will not produce a good figure, if harder an inferior polish will be the result. The pitch can be made harder by boiling or softer by the addition of oil of turpentine.

The polisher being now prepared the speculum was laid on it, being first gently warmed to about 80°, and moved about on the polisher gently until it was found that the pitch touched it at all points. Rouge and water was then applied and polishing commenced, the operator proceeding as in grinding, carefully observing that the polishing proceeded equally.

Tripoli was at first used, but is now entirely superseded by the sesquioxide of iron or Jewellers' rouge, by which name it is sold in the shops.

Mr. Mudge polished the speculum to a true spherical surface and then ended by a few large circular strokes upon the round polisher so as to increase the radius of curvature near the margin. I hope you will not consider that I have gone too much into detail, but as the machines used only change the mode of using the power, I shall not have to recur to these processes again.

The disadvantages of hand polishing are, the unequal pressure, the inability to exactly control the length and direction of the stroke, the irregular increase of temperature from friction, and finally the inability to work specula larger than eight or nine inches in diameter.

As already stated, Sir William Herschel was the first who used a machine in polishing, although it is not many years since a description of it was first published.

We shall now proceed to describe it.

Sir William Herschel's Machine.

The ring R S G surrounded the speculum which rested on the polisher face downwards; within this ring loosely fitting, and held in position by three pins above and below, there was a thin flat ring T K L, on which was screwed a ratchet ring; this annulus also carried three cocks at T, K, and L, which rest upon the speculum, with flanges projecting downwards, covered with felt, and capable of being adjusted so as to hold the speculum concentric, yet without being pinched; R C S is a claw attached to the ring by two pivots at R and S, and with an eye at C, to connect it by a pin to the lever A B, which pivots on B, the power being applied at A. D K and D L are two arms fastened

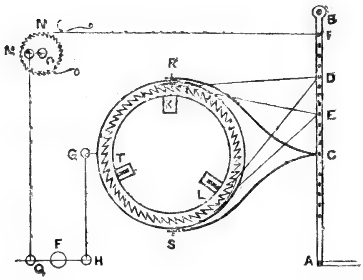


Fig. 3.

to the lever at D, and kept pressed by springs at K and L against the ratchet ring, D K ending in a hook, so that when the lever A B is pushed towards the speculum this hook seizes the ratchet ring and causes the speculum to turn a little, because the motion at D is less than at C; for the same reason, when the motion is reversed D L pushes against the ratchet ring and causes another little turn.

I N is a similar arm, causing at each pull the ratchet wheel M N to turn; this wheel carries an arm, O M, attached to the lever Q H, H being attached to the projection G; Q H pivots on F. By regulating the length of O M or F H or both, the amount of side motion is adjusted. The arms attached to the lever at E caused the polisher to revolve when a circular one was used. But Sir John Herschel states, that with a speculum of $18\frac{3}{4}$ inches diameter by using a fixed oval polisher of 1·12 and 0·97 diameters (the speculum being 1), with grooves at an angle of 45° to the stroke, he obtained most satisfactory results without using any side motion, H being then fixed in position and the arm I N detached. When the speculum and polisher are caused to revolve, with the side motion in action, the speculum will describe curves somewhat similar to those of Lord Rosse's polisher, but the shock given to the speculum at the commencement of each push and pull must be injurious. In Lord Rosse's machine this shock is not felt, the stroke being given by a crank motion. The length of stroke used on a round polisher without side motion was 0·47, and with side motion 0·29, the total side motion being 0·19, the speculum as before being 1.

Lord Rosse's Machine.

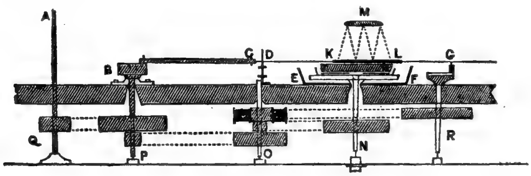


Fig. 4.

In this machine the speculum is worked face upwards, both grinder and polisher being grooved so that an even distribution of the emery used in grinding is obtained as well as of the rouge in polishing. The polisher fits loosely but accurately in the ring, so that it revolves with the speculum, but at a different rate, partly from being carried round with it by friction at the end of each stroke, and partly from the change of direction given to the stroke each time by the revolution of the eccentric.

The power is applied by means of the spindle A, which drives the spindle P, carrying the eccentric B; this eccentric gives the length of stroke, equal about one-third the diameter of speculum. P again drives O, which latter drives N and R; on N rests the speculum H I, while R carries the back eccentric G, which controls the side motion, usually about one-fifth of the diameter (measured on the side of the speculum). The diameters of the various pulleys, as now used for polishing the three feet speculum, are approximately as follows:—Those on the spindle P, 30 and 7 (inches); O, 18, 9, and 18; N 36, and R 30; G performs a revolution in about five strokes of the eccentric B, and the speculum once in about eleven; D is a fixed guide, D G being rigidly attached to the ring K L, carrying the polisher. This bar and polishing ring is supported at D, and by the fork at G, which latter is free to revolve in its socket. The polisher is counterpoised, leaving a weight of about 10 lbs. pressing on the speculum, M being a circular disc attached to one end of the lever by its centre, but by six hooks in its circumference to the polisher.

The curve actually described by the centre of the polisher in the model of Lord Rosse's machine which you see before you, of

one-third the dimensions, and on which I have frequently worked to an excellent figure a 9-inch speculum, is given in figure 5, where you have the result of 9½ strokes, 2¼ revolutions of eccentric G, and 1 revolution of the speculum, the stroke, &c., being adjusted to a 9-inch speculum.

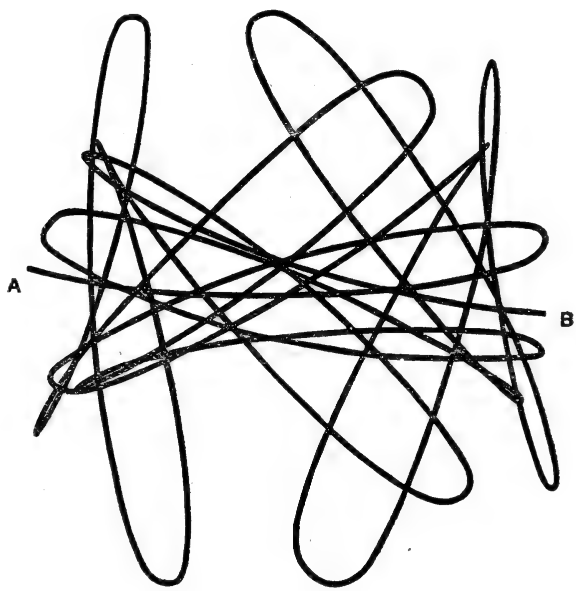


Fig. 5.

Mr. Lassell's Machine.

The power is applied in this machine to the pully I I, which drives the worm spindle H K, this drives the wheel L of 77 teeth, and by means of the band G, a similar wheel C, on which the speculum rests. The spindle M turns with L, carrying the arm S P; the wheel O is fixed to the frame N, so that as the arm S P is carried round the pinion Q of 16 teeth works in O of 72; R of 72 revolves with Q, working in the pinion T of 16; T carries with it the eccentric V; T and V can be adjusted by means of the slots as shown in the figure. A pin at V carries round the polisher J.

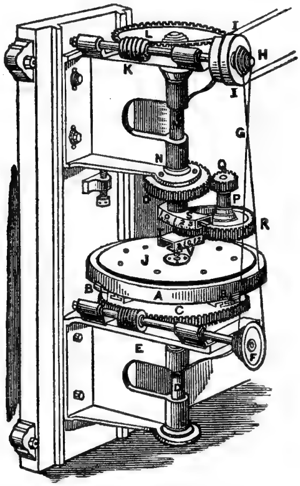


Fig. 6.

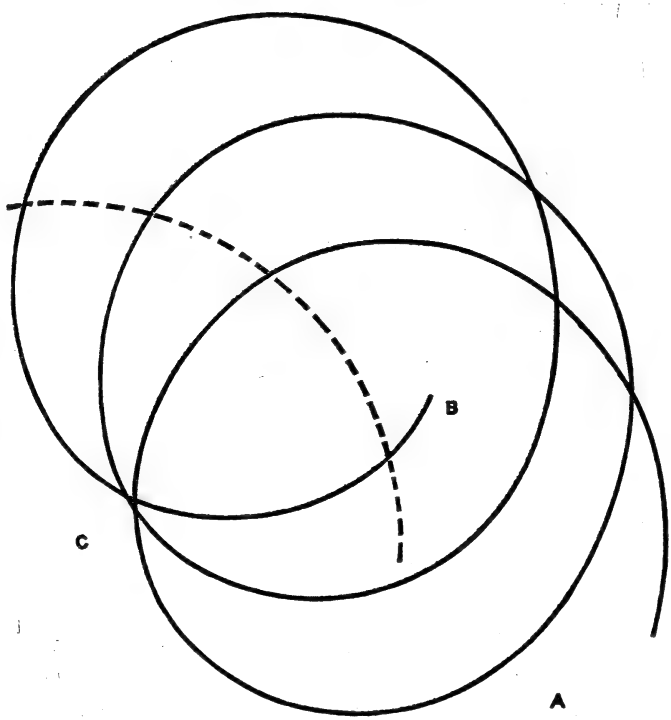


Fig. 7.

For a 2-feet speculum H K revolves about 132 times per minute; the eccentric S 1·7 times; V 34·7. The speculum A, 0·46, T being 1·7 inches from its centre to centre of spindles, M, and V being 1·4 inches from centre of T. The curve described by the centre of the polisher in these conditions is shown in figure 7. An exactly similar curve would be obtained if S did not revolve at all (the revolutions of T being unaltered), and the speculum at a speed of 1·7+0·46, the sum of their velocities, equivalent to 1 turn of speculum to about 16 of V. The dotted line in figure 7 shows the path of the centre of T, the centre of the speculum being at C. It was found by Mr. Lassell that the polishing was apt to proceed in rings to the detriment of the figure, he caused the speculum to rest on a sliding bed instead of directly on the wheel C, which being acted on by a roller fastened to the wall plate, received a thrust of about one and a-half inches on two opposite sides. Delarue made a further improvement by causing the speculum slowly to revolve on this, so that the thrust did not always occur across the same diameter.

Mr. Grubb's First Machine.

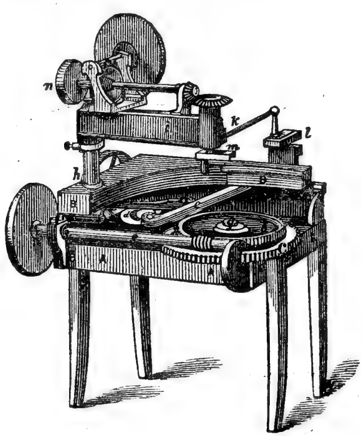


Fig. 8.

This machine gives Lassell's curves, and is capable also of approximating closely to Lord Rosse's.

f is a worm-shaft driving the wheel *b* of 90 teeth; *c* also of 90

revolves with *b* and works a wheel of 52 attached to the lower surface of the cam *d*; in the groove of this works a pin fastened to the cam-lever *e*, which is thus made to oscillate; this is linked to the sliding-plate B, which thus by the rotation of the cam is made to vibrate with a uniform motion. The plate B carries a spindle *h*, on which vibrates the arm *i*. The link *k* will either hold this arm in position or cause it to vibrate with the eccentric *l*, which is driven by a shaft at the back. The variable crank *m* can be driven either quickly by the pully *n*, or slowly by the worm-wheel *o*. The pin in *m* drives the polisher.

To give Lord Rosse's motion the pin of *m* is set central, and *l* is set in motion, this gives the stroke, the side motion being given by the sliding plate B. To give Mr. Lassell's, *l* is stopped and fixed in position, so that the pivot of *m* is equal the distance of the centre of the pinion T (fig. 6) from the centre of the speculum, the arm *i* being held firm by the link *k*; the pin of *m* is then set to the distance V T (fig. 6), and by the vibration of B, Mr. Lassell's eccentric motion can be given.

This machine Mr. Grubb has superseded by one of great simplicity of construction.

Mr. Grubb's Second Machine.

In figure 9 you have an isometric perspective view of the machine with which the great Melbourne telescope was ground and polished.

A is the speculum in its box revolving on a vertical spindle, B the polisher, a portion of the weight of which is counterpoised by a lever attached to the bar *a*. The horizontal bars *b*, *b′* are attached to *a* at *c*; these are moved by the cranks at *d d′*, which receive their motion (by means of bevelled wheels) from a horizontal bar connected with the driving pully D. By the adjustment of the length of the arms *b b′*, or of the cranks at *d d′*, a great variety of curves can be given to the bar *a*, carrying the polisher.

By means of the handle at *e* the speculum was made to turn on its edge so as to view a distant artificial star, and thus to test the figure—thus a great saving of time was effected and the risk of accident diminished.

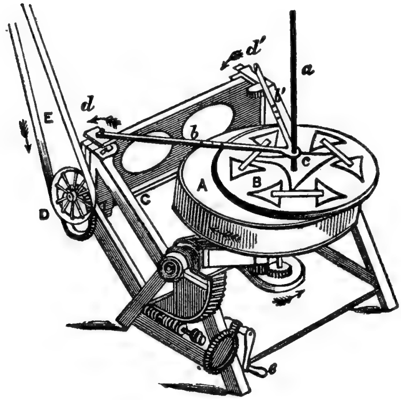


Fig. 9.

A curve produced from a similarly constructed machine set at random is given in fig. 10.

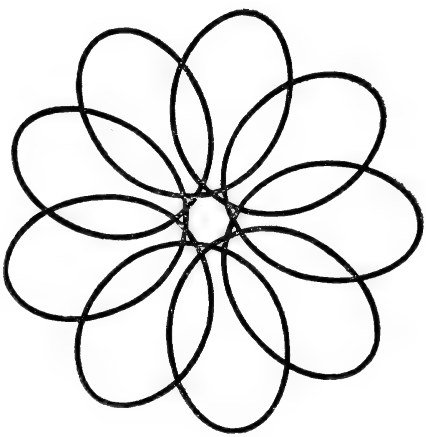


Fig. 10

It is unnecessary to speak of Foucault's process of hand abrading or the American system of local polishers, as these require highly skilled artificers to be successfully used.

The choice of machines evidently lies between that of Lord Rosse's and that of Mr. Grubb's No. 2. The latter is so compact and admits of such a variety in the curves which the polisher

may be caused to describe, that it probably deserves the preference. On the other hand, on looking at figure No. 5, and observing the variety of continuously varying curves described by the polisher in Lord Rosse's machine, one has little doubt that with it there will be less liability to polish the surface in rings than with a machine which gives a uniform curve of whatever description.

The objection that the polisher is kept too long over the edge by the eccentric (G, figure 4), is obviated by making the pully by which it is driven oval as in the machine for Lord Rosse's 6-feet speculum.

It is certain, however, that both machines have produced good results in the hands of their inventors.

NOTE.—In Mr. Grubb's Machine No. 2, one revolution of the speculum coincides with 14 strokes of the eccentrics, of which there were 33 per minute in the rough grinding, and 24 in fine grinding and polishing.

ON BABBAGE'S SYSTEM OF MECHANICAL NOTATION AS APPLIED TO AUTOMATIC MACHINERY,

BY

HOWARD GRUBB, C.E., F.R.A.S.

Read December 17th, 1877.

In the year 1826, the celebrated mathematician, Mr. Charles Babbage, presented a paper to the Royal Society of London, on a method of expressing by signs the action of machinery.

The ingenious and elegant system Mr. Babbage describes in this paper appears to have been paid but little attention to by engineers, and I can only find one mechanical author, and that of old date, treating of Mr. Babbage's system.

The fact of this (as it seems to me), most useful system of notation, having been apparently buried in oblivion, has induced me to bring the matter under the notice of this Society in the hope that it may prove as useful to many others as it has been to me. I may also say that I am further induced to notice this matter, from the fact that my father, who made considerable use of this system in planning his automatic printing, and other machinery, found the system capable of extension in directions, certainly not recorded, and perhaps never contemplated, by Mr. Babbage.

I shall first endeavour to explain the object which Mr. Babbage had in planning this notation, then the principle of the system, and lastly the uses to which it may be applied.

Firstly. The object Mr. Babbage aimed at was to supply a serious want which he felt existed in graphically representing an elaborate piece of machinery. He desired to devise such a method of graphical representation as would present to the mind of the mechanic a true representation, not so much of the general form and disposition of the small parts, for that can be done by ordinary draughtsmanship, but of the quantity and nature of the different movements, the time each movement occupies, and the sequence of such movements, &c. Such a representation could no doubt be made by a series of drawings of

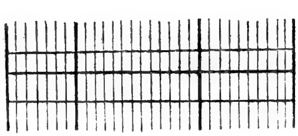
each part, showing the machine in every possible position, but this would require enormous labour, and numerous sets of drawings for each individual position of the machine, and such, even if accomplished, would not fulfil the required conditions, for it would be almost impossible for any person to properly follow the various motions through these elaborate drawings, and carry in his mind the true nature of the movements.

Mr. Babbage's system, however, enables a person who has a slight mechanical knowledge, and a very little practice, to perfectly understand the complicated movements of a piece of machinery like this automatic numbering machine,* from a few minutes study of a single chart, on which all its motions are laid down according to his system.

Secondly. The principle of this system of notation may be thus described :—The various movements of the machine are classified, and named, and placed, one under the other in the first column of the sheet. Opposite them is a portion ruled into small vertical columns, which in its total horizontal dimensions is supposed to represent a certain space of time, in fact the time occupied by the machine in completing one period or cycle of its duty. This may be divided into any convenient number of parts. In the present case as the machine completes a cycle in about six seconds, I have divided the space into six parts, and each of these again into ten, representing tenths of seconds.

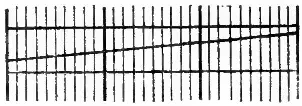
The vertical distances represent, on various empirical scales, "spaces" travelled over by that particular part of the machine specified in the first column.

As the horizontal distances represent "*time*," and the vertical space, any portion of a machine at rest for any particular number of seconds, or tenths of seconds, is represented by a horizontal line, thus :—



* An automatic numbering machine, the invention of Mr. Thomas Grubb, F.R.S., was exhibited as an illustration to this paper.

A uniform motion is represented by an inclined straight line, inasmuch as the spaces passed over in each unit of time are equal:—



A crank motion which begins gradually, attains its greatest velocity in the centre of its half-stroke, and ends also gradually, is represented thus:—

In fact the space passed over in any particular unit of time, is represented by the difference of the ordinates at beginning and ending of that unit.

A glance therefore at the accompanying chart will show the actual positions of all parts of the machine at any particular tenth of a second during the whole six seconds.

Thus, for example, it will be seen in the first line that the inking rollers roll backward and forward by a crank motion (or motion analogous to it) six times during a cycle. In the second line it will be seen that the inking rollers rise uniformly, and attain their highest level in three-tenths second; then they continue (rolling backward and forward, as the first line has previously informed us), for 1·1 seconds; they then uniformly descend and ascend again (to change position of rollers) in 0·6 second, continue at their highest level, inking the rollers for 0·6 second, and then uniformly descend and spend the remainder of this time, 3·0 seconds, in taking up fresh ink.

I might go through all the lines in the same way, but as the same principle applies, it is hardly necessary as a very little study will render the matter quite plain.

Thirdly. The uses to which this system is capable of being applied are numberless, and seem to continually increase as one gets

more conversant with the principle and practical working of the system. They may, however, be classified into three heads:—

(*a*). The designing of the machine.
(*b*). The working out of the details of construction.
(*c*). The putting together of the machine.

(*a*). Let us first consider the designing of the machine. Whatever difficulties there are in understanding the working of a complicated machine from accurate drawings made after the machine is completed, or even from the machine itself, much greater are the difficulties to be encountered in designing the machine, for in this case the designer has neither machine nor drawings to guide him, and the only representation of the machine lies in his own brain; while, therefore, he mentally plans one part, he has to keep in his mind (if he can) the relative positions and actions of all the other parts, and frequently to go back in his work and modify and remodify various parts in his mind's eye, and all this must be thought out before he puts pen to paper; for after all, *mechanical drawings represent, not the actions and motions of the machine but the appliances (levers, wheels, cams, &c.), by which these motions are produced.* We cannot plan these appliances before we know what is required for each part to do.

What we do want, therefore, is a means of graphically representing the various motions and actions of the machine without reference, in the first place, to the nature of the mechanical appliances by which these various motions and actions are effected. I have said enough I think to show that this part is most admirably fulfilled by this system of notation, for as the designer plans motion after motion, and action after action, he represents the nature, direction, quantity, and quality of each by these various curved lines, and can go backwards and forwards touching up and modifying the various actions (without taxing his brain to carry the nature of all or any one of these actions), until he gets all to his satisfaction, and in proper sequence.

(*b*.) The next task of the designer is that of working out the details of construction of the machine, and here again the system assists him, for he can decide from the nature of the curve on his chart (which curve he has before decided on to be the best

possible for that particular purpose), what class of motion, whether crank, link motion, wheels, or cam work, he should adopt, and supposing he is required to adopt the more complicated form of cam work, the curve on the chart will enable him to sketch directly, and without any calculation the shape of his *cam*.

(*c*.) Now as to the putting together of the machine. I do not mean by this, simply the reputting of the machine together after it has been once completed, but I mean the putting together for the first time of the various parts which have been separately and disjointedly completed to scale drawings, the ascertaining of the exact position in which to place each wheel, levers, and cams, so that all may work properly, and each part fulfil its proper duty, *and at the proper time*. In complicated machines, this is the one operation in which above all others, workmen are apt to make mistakes, for as the appliance for each motion has to be placed and "keyed" independently, it is very difficult indeed to say, except by a laborious tentative system of trial, whether that particular motion tallies perfectly with all the other motions, not only these already attached, but those to be attached.

Here again Mr. Babbage comes to our assistance, for by attaching to the main shaft of the machine (which makes one revolution for each cycle), a cardboard disc divided into the same number of parts as the chart, we have in keying on any particular motion, only to bring the shaft round till the divided disc reads such a division as corresponds to some certain action of that particular cam, or lever—say the commencement or end of some particular action, and then turn the cam or lever on the shaft until that action does actually take place, and there key it, and so on through all the motions: so that really the workman might put the whole machine together, find out the position for all the motions, key them on, and be perfectly satisfied in his own mind, that the machine will work perfectly correctly, *even though he never tried it once*.

It may be said that a mathematician could describe and note down the nature and quality of all these actions without reference to a graphical representation. No doubt; but in the first place the mathematics required even for very simple machinery would be far higher than what we can expect mechanics to be conversant with, and I think we need no argument to show that a mathe-

matical explanation of the mechanical motions would not satisfy the requirements even of a highly educated mechanic, when we find Mr. Babbage himself, one of the greatest mathematicians of this century, actually engaged in devising this system of graphical representation.

SUGGESTIONS FOR AN EXPERIMENT TO DEMONSTRATE THE POLARIZED STATE OF THE GAS IN CROOKES'S LAYER.

BY

GEORGE FRANCIS FITZGERALD, M.A., F.T.C.D.

[Read 21st January, 1878.]

I DESIRE to apologise to the Society for bringing before them only a proposed instead of a performed experiment, but my excuse is that it will probably be some time before I am able to perform the experiment myself, and as I desire to get credit for having at least proposed it, I take this opportunity of publishing it, and of giving my reasons for supposing it likely to be successful, by showing that the quantities involved are quite within the reach of our present methods of observing them.

I would first notice that, according to both Clausius and Maxwell's theories of the conduction of heat in gases, the existence of a force like Crookes's depends essentially upon the distribution of the velocities among the molecules, it being easily seen from either of their investigations (as is also evident from many other obvious considerations) that it is quite possible to imagine such a distribution of velocities among the molecules as that, though heat be propagated through the medium, yet the pressure in all directions shall be the same. Hence, any independent method of demonstrating a polarized state of the gas is of considerable importance; and the experiment I am about to propose is for the purpose of doing so.

When any homogeneous transparent substance is in a state of stress, its refractive index for light, polarized in certain planes, is different from that for light polarized in other planes, and consequently a ray of plane polarized light, when passed though such a medium in certain directions, emerges elliptically polarized. If the gas in a Crookes's Layer be in the state of stress that theory indicates, it ought to behave similarly, and a plane polarized beam when transmitted along it should emerge ellipti-

cally polarized. Now, the amount of elliptic polarization, we may expect, can be calculated in the following manner:—I have estimated by a series of unfortunately rather rough experiments that when a red hot ball is plunged into cold water to a depth of half a centimetre, the thickness of the Crookes' Layer formed, is about a quarter of a millimetre. This is, of course, only a rough approximation, but it will give us results which determine with what order of quantity we are dealing. Hence, the excess of pressure in the vertical over that in the horizontal direction that I measured was half a gramme per sq. centimetre, which is about the ·0005 of the atmospheric pressure. Now, I will make an assumption which is, however, only partially true, but as one object of the experiment is to determine to what extent it is so it is legitimate provisionally, and it is that we may treat the strain in the gas as due entirely to a difference of density in different directions. That we may do so to some extent, at least, is manifest, for, according to theory, the number of molecules moving in the direction of the strain is greater than the number moving in other directions. To what extent this is true could only be determined either by elaborate theoretical investigations into the state of the gas or else by experiments such as I am proposing. Assuming then the strain to be wholly due to a difference of density we can proceed as follows:—The law connecting the refractive indices of a gas at different densities is $\frac{\mu - 1}{d} = \frac{\mu' - 1}{d'}$ so that in air when $\mu = 1{\cdot}0002940$, and in the case we are considering where $\frac{d'}{d} = 1{\cdot}0005$ we have $\mu' = 1{\cdot}0002941$. As there are 100,000 vibrations of light per five centimetres *in vacuo* there will be 100029·40 when the density is μ, and 100029·41 when it is μ', and consequently a difference of phase of ·01 of a wave length will be introduced per five centimetres or a twentieth of a wave length in 25 centimetres. Now, as the intensity of light in the analyzer depends upon the square of the sine of the difference of phase, this will give the intensity as the square of the sine of 9°, which is ·02 or $\frac{1}{50}$th. Hence I conclude that if a ray of plane polarized light be transmitted through 25 centimetres of a Crookes's Layer between two surfaces, one of

which is red hot, and the other below the temperature of boiling water, and with an interval between them of a quarter of a millimetre, then one-fiftieth of the light will be restored in an analyzer which was so turned as to extinguish the beam before transmission between the plates. Such an effect could be easily observed, but as it is very unlikely that the whole of the strain in a Crookes's Layer is due to a difference of density of the gas in different directions, it is very unlikely that so great an effect would be produced. One object, however, in trying the experiment would be to determine to what extent the strain is due to a difference of densities.

ON THE BARYTES MINES NEAR BANTRY.

BY

EDWARD T. HARDMAN, F.C.S., of the Geological Survey of Ireland.

[Read January 21st, 1878.]

SULPHATE of Barytes or Heavy Spar is a mineral of not very common occurrence in Ireland, and is only met with in a few localities in sufficient quantity to be of commercial value. In various places in the county Cork it is found in some abundance; and near Bantry it has been, and I believe is at present, being extensively worked. Having visited these mines some time ago, I propose giving a brief description of them.

The most extensive lode is met with in the townland of Derryginah, Middle, about two miles east of Bantry. It bears nearly due east and west, N. 80° E. & S. 80° W.; cutting the strike of the Old Red Sandstone slates, at an angle of about ten to fifteen degrees. The lode is ten to fifteen feet thick, and has been followed for some 200 or 300 yards, the workings extending to a depth of about fourteen fathoms. About one-third of the lode in the centre consists of extremely pure Barytes, but the sides of it consist of an impure variety called cawk, which contains a quantity of quartz, carbonate of lime, green carbonate of copper, Peacock copper ore, and micaceous or specular iron. The last is found in considerable quantity—so much so, that the manager of the works was of opinion it might prove commercially valuable could it be smelted.

Besides the difference in purity of the Barytes, two varieties occur in this lode. One a crystalline glassy-looking specimen; the other a granular saccharoidal variety, and the last is the kind most valued, as it is the most easily ground in the process of preparation.

From this mine a considerable quantity of mineral has been obtained and exported by the Bantry Barytes Mining Company, who are now working it. When in full work they can easily turn out twenty tons per day. But the mine is capable of yield-

ing a much larger quantity, being in fact so far only limited by the amount of labour obtainable, and the state of the market. Owing to the cost of carriage also, the price of the mineral is necessarily rather high.

The next locality for Barytes is a little more than a mile south-east of Bantry, in the townlands of Ardargh and Darreengreanagh, and so far as I know of, has not been mentioned in any list of localities of that mineral; although the occurrence of the lode is marked in the field maps of the Geological Survey. And the mode in which it occurs is sufficiently curious to deserve a passing notice.

This deposit occurs in similar grits and slates to those enclosing the first named, but instead of forming a lode it consists of a thick pipe-like mass of nearly pure Barytes. This pipe is about thirty feet long, and fifteen wide, and it has been proved to extend downwards for at least ninety feet, having been entirely excavated to that depth. At the corners it throws off small branches or veins, from two to five feet thick, and some of these have been found at the surface some distance from the main body, but appear to thin away on every side.

This great mass is almost entirely composed of the very purest sulphate of Baryta. An analysis of it showed it to contain over ninety-five per cent. of sulphate. The "seconds" or "cawk" (which forms but a very small proportion of the lode, being principally confined to the walls), contain various copper ores, the green carbonate, Peacock ore, and copper pyrites, as well as galena, all in very small quantity. The walls of the lode are coated in some places with steatite, or chlorite. The rocks enclosing it strike N. 80° E., with a high dip of 75° to 80°.

This deposit has been worked for a considerable time by the Scart Barytes Mining Company, and the principal mass of ore has been removed to the depth above stated—ninety feet.

There is always an amount of mystery kept up as to the uses for which Barytes is intended, arising from the fact that it is chiefly in demand for purposes of adulteration, its high specific gravity being taken advantage of. Thus it is principally in request for the adulteration of white lead and other paints; and some even say that it is employed as a commercial substitute for

sugar. Such at least is the Bantry native opinion. It is besides occasionally useful for the manufacture of glazes for porcelain*.

The mineral is worth about £1 per ton, delivered free on board at Bantry, but when ground and prepared it fetches £4 per ton.

A few words on the probable mode of formation of this mineral may not be out of place. And first I may mention that many of the Irish localities for veins of sulphate of Barytes appear to lie in the Old Red Sandstone. Thus Portlock records its occurrence in the Old Red Sandstone of Ballynascreen and Desertlyn, county Derry, and Clogher, county Tyrone. But this is merely a coincidence, because is it found here as in other counties in many other rocks, crystalline and sedimentary, and in England it occurs largely in the Carboniferous limestone. Now it is tolerably easy to account for the presence of veins of this mineral in limestone, which is easily soluble and quickly worn into fissures or pipes by ordinary atmospheric water, in which, under some circumstances, Barytes might be deposited, but the first difficulty with which we have to contend in this case is the solution of such rocks as sandstone and slate. The Derryginagh deposit can be accounted for by a simple fissure, but this will not account for the other case, in which the original material has been removed in the form of a nearly square pipe, which could never have been produced solely by fissuring. There can be no doubt but this receptacle has receivedits present form through the action of water. Doubtless such pipes are due to fissures in the first instance which, allowing the water to percolate freely, are eaten away bit by bit into their present form.

Age of these Veins.—As these veins run partly along and partly across the strike of the strata, which lie in flexures dipping at high angles, it follows that they must be of more recent date than that of the upheaving and flexuring of the Old Red Sandstone and Carboniferous rocks of the south of Ireland. Now, as Professor Hull has shown, these flexures are due to forces acting at the close of Carboniferous and previous to the Permian Periods.† It

* It appears to me that the granular varieties might, with advantage, be substituted for alabaster, for statuary and ornamental purposes. The mineral can be obtained in large blocks.

† Jour. Roy. Geol. Soc., Ireland, iv., pt. iii., p. 114.

is certain therefore that these lodes, as well as the copper lodes of the other parts of Cork as well as Kerry, are younger than the Carboniferous period, and may be therefore about the same age as those of Cornwall. It is, of course, impossible to determine at what period past the Carboniferous they have been deposited, since there are no newer strata in this part of Ireland; but however this may be, we may suppose that the original fissures were most likely opened during the disturbances which produced the flexures of the Old Red Sandstone in the south-west of Ireland.

Deposition of the Barytes and associated Minerals.—Barytes being one of the most insoluble substances known, it is unlikely that it could have been deposited from solution in cold water; on the other hand it is so very infusible that the heat necessary to reduce it to a plastic condition would be more than sufficient to melt the surrounding rocks. Its deposition is therefore to be ascribed with most probability to the action of thermal springs, the waters of which were forced upwards into these fissures, while the strata at present exposed were still buried under a great mass of superincumbent rocks. The waters at first warm enough to hold small quantities of such difficultly soluble minerals in solution would, as it came nearer the surface, become somewhat cooler, and these minerals would be then deposited along the sides of the fissure. This point, which is insisted on by Delesse, is demurred to by Bischof, who considers that the waters of ascending hot springs cannot produce these deposits, but it is evident he left out of consideration the cooling of the water as it rose.

Source of the Sulphate of Barytes.—This is to be sought for either in the immediately outlying or surrounding rocks, or in masses of rock at some distance, from which some compound of barium may be carried down into springs. Carbonate of barium is by no means an uncommon mineral, and barium in some form is of common occurrence in minute proportion in limestone. Silicate of barium is also found occasionally in igneous rocks, and might, therefore, also occur in parts of the Old Red Sandstone which are derived from the debris of such rocks*. Those com-

* The very small quantity of Barium compounds disseminated through rocks, is of little moment in this consideration. As Bischof well remarks, the minimum quantities in rocks may become the maximum quantities in lodes.

pounds of barium are to a small extent soluble in water, and would be brought down through the strata to rise again from deep-seated springs. Meeting now with soluble sulphates, these salts of barium would be converted into sulphate, and as the water cooled in rising to the surface, this would be deposited. As a matter of fact crystals of sulphate of barium have been found on the granite of Carlsbad, where a hot spring, containing in solution traces of that substance, burst out. Chloride of barium is sometimes noticed in spring waters, and this would also give rise to sulphate in the manner pointed out.

In fact it is only through the medium of hot water that the sulphate of Barytes of Bantry, and the very insoluble minerals associated with it, can be supposed to have been deposited.

ON THE ARTIFICIAL PRODUCTION OF MINERALS AND PRECIOUS STONES.

BY

MM. FEIL AND FRÉMY.

[Read January 21st, 1878.]

THE artificial production of minerals presents, in a scientific point of view, an interest which everybody understands. It has long afforded a wide field of research to many scientific men, among whom may be mentioned Ebelman, Senarmont, Deville, &c.

We thought it might be interesting, even after the works of these eminent scientific men, to publish the result of our researches on the crystallization of alumina and of divers silicates.

If we place in a furnace, heated to a high temperature, a mixture of alumina and oxide of lead, we obtain white crystals alumina, and, by adding a metallic oxide as colouring matter, —either chromium for obtaining a red colour, or cobalt for blue,— we can produce rubies in the first case, and sapphires in the second. It is necessary, however, in order to procure chemically pure crystals, from the mass obtained to separate the lead which may yet remain in combination with the vitrifiable earth proceeding from the crucible, and which may itself have been combined during the fusion. We may separate these bodies by different processes, either by the action of hydrofluoric acid or by potash in fusion, or by prolonged calcination in hydrogen, and subsequent treatment with alkalies and acids.

The following are the properties of the rubies we obtained:— They scratch quartz and topaz. Their density is 4·0041.

They lose, like natural rubies, their pink coloration when they are strongly heated, and regain colour on cooling. They are as hard as natural rubies.

When submitted to optical examination—that is to say, to the microscope of polarization of Amici—our rubies, which have the form of hexagonal prisms, present the characteristic black cross and coloured rings.

The crystals we obtained, and which we had cut by a lapidary, have not yet the requisite limpidity for commercial purposes neither do they present to the lapidary favourable facets

for cleaving; but they have the colour and the hardness, &c., and we have prepared large masses in which crystals have been found which leave absolutely nothing to be desired. Besides, we are still studying this interesting question, and without doubt we shall soon arrive at a perfect result in every point of view.

The second part of our investigation, *i.e.*, that on the crystallized silicates, will serve to demonstrate the influence of the fluorides as crystallizing agents. By submitting to heat, during a determined time, a mixture of fluoride of aluminum and vitrifiable earth, we noticed that, by the mutual reaction of the two bodies, fluoride of silicium is evolved, and we obtain a crystallized body which seems to be disthene—that is to say, a silicate of alumina. It appears under the form of acicular double refracting crystals, which extinguish the light obliquely towards their edges. These crystals afforded on analysis the following results:—

Vitrifiable earth,*	47·65
Alumina,	51·85
Loss,	0·50

It is about the same as for disthene, or its varieties, trebolite, bucholzite and bamlite, and sillimanite.

By operating in a certain manner, and by heating to a high temperature a mixture of alumina and fluoride of barium, we obtained prismatic needles several centimetres in length. Their analysis afforded:—

Vitrifiable earth,	34·32
Baryta,	35·04
Alumina,	30·37

M. Jannettez has ascertained that these long prisms are often composed of four blades with parallel faces forming the surfaces of a hollow prism; they extinguish the light under the microscope, or rather they let the obscurity persist between two crossed prisms. They may be cut at angles of 60° 42′ and 119°.

In the course of the reaction which generates the crystallized double silicate just described, some corundum is formed. These bodies are the results of the following changes:—

By heating the mixture of alumina and fluoride of barium, fluoride of aluminum and barium is formed.

*This term is doubtless used as a synonym of silica.—*Eds.*

Having once first produced fluoride of aluminum and decomposed it again under the influence of steam, hydrofluoric acid is formed and corundum is crystallized.

By acting at the same time on the vitrifiable earth of the crucible, there is first produced some silicate of alumina, which by uniting itself with baryta, has produced the beautiful crystals of double silicate of aluminum and of barium which we have presented.

Such is the theory we think rational; and it seems to result from our experiments that fluorides are not only excellent mineralizers in the mass, but that they can carry along with them the most fixed bodies. As a proof of this assertion one can instance that remarkable formation of orthose felspar produced artificially in the upper part of a copper furnace at Mansfeld. The use of the fluoride of calcium in the bed of fusion, which produced that felspar, permits us to suppose that the fluorine served here as a transporting agent or vehicle.

Thus, we are justified in expecting that, by prosecuting our studies, we may be able to produce crystals capable of application in jewellery and watchmaking. The last experiments have shown us that we are making good progress. We have already obtained cut crystals of remarkable value. We hope they will shortly be presented for inspection.

THE FOLLOWING PAPERS were also read and ordered to be printed in the *Transactions of the Royal Dublin Society*:—

1877.

Nov. 19th.—WENTWORTH ERCK, LL.D., F.R.A.S., "On the Satellites of Mars."

Dec. 17th.—EDWARD HULL, F.R.S., and E. T. HARDMAN, F.C.S., "On the Nature and Origin of the Chert-beds in the Upper Carboniferous Limestone of Ireland."

1878.

Jan. 21st.—T. ROMNEY ROBINSON, D.D., F.R.S., "On the places of 1,000 stars observed at the Armagh Observatory."

VERBAL COMMUNICATIONS were also made to the Society on the following subjects:—

1877.

Nov. 19th.—On Phenol-phthalein as a test of Alkalinity by Professor J. EMERSON REYNOLDS, M.D.

" " On Specimens of Crystallized Phosphorus, exhibited by Mr. R. J. MOSS, F.C.S.

" " On the limits of Geological Time by Rev. S. HAUGHTON, M.D., F.R.S.

" " On the relation of Science to Practical Engineering by ROBERT MANNING, C.E.

Dec. 17th.—On a simple form of Telephone exhibited by Professor W. F. BARRETT, F.R.S.E.

" " On a new form of Spectroscope, exhibited by Mr. HOWARD GRUBB, M.E., F.R.A.S.

" " On the discovery of Brine in the Valley of the Mersey at Warrington by Professor HULL, F.R.S.

" " On Specimens of ornamental and other stones from Jypore, India, exhibited by Professor E. Hull, F.R.S.

" " On Specimens of Idocrase rock from Cumberland, exhibited by Professor HARKNESS, F.R.S.

" " On Nests of the oven-bird (*Furnariidæ*), exhibited by Professor MACALISTER, M.D.

" " On an Automatic Numbering Machine, exhibited by Mr. HOWARD GRUBB, M.E., F.R.A.S.

1878.

Jan. 21st.—On M. Cailletet's experiments on the liquefaction of Oxygen and other gases, by Professor J. EMERSON REYNOLDS, M.D.

" " On the Phonograph, by Professor W. F. BARRETT, F.R.S.E.

Jan. 21st.—On the relation between the electric and capillary properties of a surface of mercury in contact with different liquids, by Mr. G. F. FITZGERALD, F.T.C.D.

" " On new forms of Laboratory apparatus for obtaining heat and light, exhibited by Mr. R. J. MOSS, F.C.S.

" " On the Glacial phenomena of upper and lower Lough Bray, by the Rev. M. H. CLOSE, M.A.

" " On *Totanus Haughtoni*, (Armstrong) a new species of Greenshank from India, exhibited by Professor A. MACALISTER, M.D.

" " On Specimens of Barytes and associated Minerals from Bantry, exhibited by Mr. E. T. HARDMAN, F.C.S.

" " On Nests of Mason-bees from Rayal Pindi, Ladakh, exhibited by Mr. J. W. HAUGHTON, junr.

" " On a series of Human Vertebræ with anomalous processes, exhibited by Professor A. MACALISTER, M.D.

" " On Nests of Trapdoor Spiders from Jamaica, exhibited by Professor A. MACALISTER, M.D.

" " On the skull of a Fanti from West Africa, exhibited by Professor A. MACALISTER, M.D.

" " On a new form of Tell-tale clock, exhibited by Mr. W. HANCOCK.

" " On a Gas-light improver; also on a new form of gas engine, used with the Gramme Magneto-electric machine, exhibited by Mr. JOHN R. WIGHAM.

THE PHYSICAL GEOLOGY OF THE NEIGHBOURHOOD OF DUBLIN.

BY

REV. MAXWELL H. CLOSE, F.G.S.,

With a Map.

[Read February 18th, 1878.]

THE following account of the Physical Geology of the country around Dublin has been drawn up, principally from the Maps and accompanying explanations (Nos. 102, 112, and 121) published by the Irish Geological Survey, from papers in the Journal of the Royal Geological Society of Ireland, in the Transactions and Proceedings of the Royal Irish Academy, and from the Journal of the Geological Society of London. For further information on the subject the reader may have recourse to the memoirs above named, to the late Professor Jukes' "Manual of Geology," to Professor Hull's "Physical Geology and Geography of Ireland," and to Mr. G. H. Kinahan's "Manual of the Geology of Ireland."

The immediate vicinity of Dublin is low-lying ground and was formerly called *Sean Magh Ealta Edair, i.e.,* The ancient plain of the flocks of Edar. It is part of the Carboniferous Limestone plain which so largely occupies the central region of Ireland, and which only reaches the coast in a few places, as near Dublin. On the south side of Dublin the older rocks emerge from beneath the Limestone and rise to form the hill country of S. Dublin, Wicklow, and Wexford counties. Northward of Dublin Bay there are isolated exposures of the older rocks in the Hill of Howth, the islands of Ireland's Eye and Lambay, on the adjoining coast at Portrane, and in the country around Balbriggan.

The following are the formations which present themselves within the district now to be described, viz., Cambrian, Lower Silurian, Old Red Sandstone (?), Carboniferous Limestone, Upper Carboniferous Shales (Yoredale), Granite and other igneous rocks, and Pleistocene Drifts.

The accompanying map, drawn by Mr. R. G. Symes, F.G.S., of the Irish Geological Survey shows the boundaries of the surface exposures of the various formations ; it is therefore unnecessary to describe them here. We shall adhere, as far as possible, to the chronological arrangement of our subject.

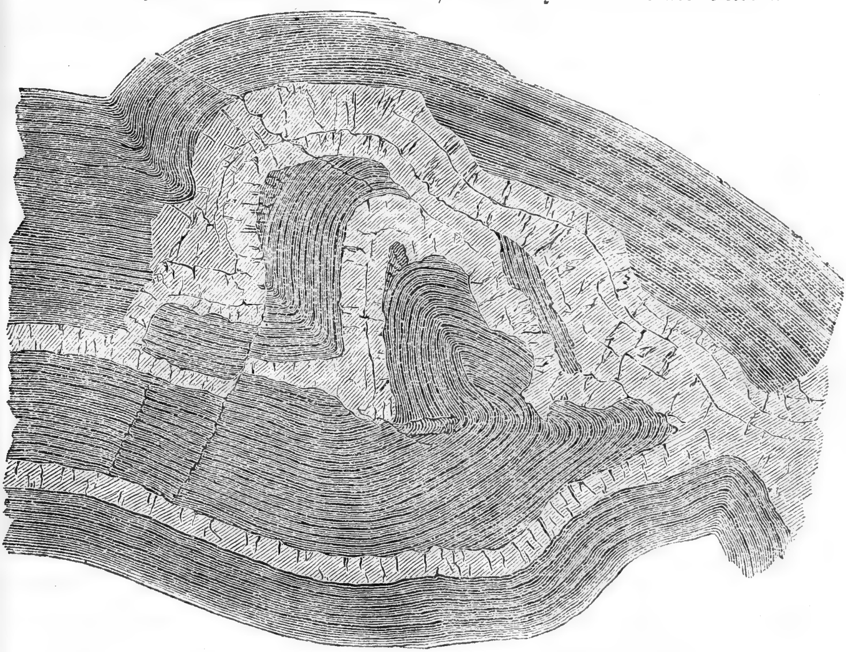
CAMBRIAN (correlative with the Longmynd rocks; "Lower Cambrian" of Sedgwick). Rocks of this formation constitute the whole of the Hill of Howth whose highest point is 563 feet (the low-lying north-western part of the peninsula is covered with Carboniferous Limestone). They occupy also the northern and western parts of Ireland's Eye, the island on the north side of the Howth Peninsula. In the southern part of our district there is a small exposure of them forming the upper part of Carrickgollogan Hill, or Shankill, 912 feet, between the Scalp and the sea. They then emerge on the near side of the town of Bray and extend thence along the coast for about 14 miles. They then leave the coast but still extend southward as far as the latitude of the town of Wicklow, that is for a length of sixteen miles altogether, with a mean width of about five miles, and they appear again in the S.E. part of county Wexford. In addition to Shankill, already mentioned, the principal eminences into which they rise near the southern part of our district are Bray Head, 793 feet, the Little Sugar Loaf, 1,120 feet, the Great Sugar Loaf, 1,659 feet, and the Downs Hill, 1,232 feet. This broken ridge, or line of hills, was called by Sir Roderick Murchison, the backbone of Ireland. As neither the bottom nor the top of the formation is visible, its thickness in this district cannot be ascertained.

Hill of Howth.—The Cambrian Rocks which form the hill part of the peninsula of Howth are generally greenish-grey, sometimes green and red, grits and slates, with numerous bands of quartz-rock, often of considerable thickness. A fine section of the rocks is displayed in the sea cliffs along the eastward and southern sides of the peninsula, for a length of at least three-and-a-half miles. The beds are much contorted and faulted; but it would appear that they have, in the mass, an E. and W. strike, with a general steep dip to the S.

Many of the quartzose rocks on the S. side, as also those of the N.E. angle of the peninsula, have a peculiar nodular structure. A great number of trap dykes are to be seen in the cliff

sections all the way from Casana Rock, on the E., to a little beyond Drumleck Point on the S.; most of these are only to be reached in a boat. Some of them, as for instance that at the Bailey lighthouse, are composed of basalt. Notwithstanding certain lithological peculiarities in some of the rocks of Howth Hill, there can be no doubt but that they belong to the same formation as those of Bray Head, &c., viz., the Cambrian, since *Oldhamia antiqua* (not very well preserved) was found in them by Dr. J. Kinahan, at Puck's Rocks, near the N.E. point of the peninsula.

PLAN.—Quartz-rock and Slate near Howth, immediately east of the Needle Rocks.



Drawn to scale (8 yards to an inch) by the late Mr. John Kelly.

Bray Head.—The precipitous sea-side of Bray Head presents for a length of nearly two miles, a fine continuous section of the Cambrian Rocks, which here are greenish, reddish, and purplish, grits and slates, with bands of quartz-rock. The beds have a general dip to N.N.W., or N., at from 40° to 70°. Allowing for contortions and faults there must be a thickness of nearly one mile of the formation exposed here. Several thick bands of

quartz-rock strike across the Head. They give rise to the ridges and knobs on the top of the hill. Some of them are cut off by a fault which runs parallel to the shore line, and thus do not appear in the sea-cliff section. One, which is seen on the shore between Periwinkle Rocks and Brandy Hole, and is 50 yards thick, passes across the summit 653 feet and then, by a curious accident, is met at the fault by another very similar one which extends for three quarters of a mile farther to near Kilruddery House. Another prominent band of quartz-rock appears on the shore at half-a-mile N. of the point of Bray Head. It is pierced by one of the railway tunnels. It (that is its visible part) is clear of the fault just mentioned and runs across the summit, 793 feet, the highest point of Bray Head, and thence extends, as it would seem, continuously by Windgate to near Belmont House, altogether a distance of two miles. These bands of quartz-rock are generally conformable with the stratification of the other rocks; but it is interesting and important to observe that they sometimes assert their independence of the stratification in a way that is not easy to explain. Mr. G. H. Kinahan, in his "Manual of the Geology of Ireland," contends that this is only to be explained by such quartz-rock (which he distinguishes from quartzite) being intrusive.

A faulted dyke of greenstone is seen in the coast section, just on the S. side of the railway tunnel above mentioned. This is an interesting object, as, with the exception of the dyke on the shore at Greystones, 2½ miles farther S., no other igneous dykes have been found in the Cambrian rocks of that neighbourhood, although they are so numerous at the Hill of Howth.

The *Little* and the *Great Sugarloaf* are composed of rocks which are lithologically similar to those of Bray Head, but with a greater proportion of quartz-rock, of which their summits are formed. They appear to be contained in a synclinal basin, through the middle of which the intervening valley of Kilmacanogue has been denuded. No fossils have been detected thereabouts except at the E. side of the Little Sugarloaf, and the W. side of the other.

Greystones, which is situated on the coast, a little beyond the southern margin of our map, has a good exposure of the Cambrian rocks on the shore. These dip, for the most part, steeply northward, and contain two massive beds of quartz-rock and the in-

trusive dyke, already mentioned, of coarse crystalline diorite, a rare feature in that neighbourhood.

Disturbance and Denudation.—Owing to the confused condition of the strata the relation between the Cambrians and the immediately superincumbent rocks is very obscure; so much so that in this neighbourhood it could not be determined; but in the country south of the Devil's Glen, Co. Wicklow, in the hills near Ashford, it is seen that the Cambrians had suffered considerable disturbance and denudation before the overlying strata were laid down unconformably upon them. The actual junction of the two formations can be seen in Pollshone Harbour, north of Cahore Point, and in Bannow Bay, both on the coast of Wexford. The overlying rocks are Lower Silurian, of Llandeilo and of Caradoc age. It seems most probable that the disturbance and denudation were contemporaneous with the similar actions which produced the unconformability which is now known to exist between the Tremadoc and the Arenig rocks.

Lower Silurian (below of Llandeilo, above of Bala or Caradoc, age, "Upper Cambrian" of Sedgwick).—The rocks of this formation here consist of thin-bedded, black, and grey, sometimes greenish, rarely purple, clay slates and fine greenish, and dark grey, grits, with, very rarely, beds of limestone (while purple slates, rare in this formation, are common in the Cambrian, black slates, common in this formation, have not been found in the other). The thickness of the strata in this district is unknown, but it must be many thousand feet; in S. Wexford it must be 10,000 or 12,000 feet.

Around *Balbriggan*, beyond the northern boundary of the map, there is an exposure of this formation, about 40 square miles in area, the southern extremity of which just comes within the limits of the map. Shenick's Island, the largest of the Skerries, is composed of beds of this formation dipping S.S.E., at 40° to 50°, on which lies, at one place, a small thin flake of nearly horizontal beds of conglomerate and sandstone, belonging, if not to the Old Red Sandstone, yet to the base of the Carboniferous formation. The Lower Silurian grits and slates are interstratified with beds of contemporaneous trap, often porphyritic, with layers of trappean ash. Some of the trappean rocks are several hundred feet in thickness. This interesting spot should be visited at low tide.

At *Portrane* there is, on the shore, a small, but very noticeable, exposure of this formation. The beds are sometimes much contorted, but their general dip on the shore is towards S. of E. The rocks consist of slates and shales containing graptolites and trilobites, with some grits and, more especially, highly fossiliferous beds of limestone; all the fossils being of Bala or Caradoc age. There are also several interstratified beds of trappean ash, evidently connected with the contemporaneous felstone porphyry close by on the W. and S. There is, in some places, a well defined cleavage whose planes dip about S. 30° E. at 40°.

Lambay Island is 2½ miles off Portrane. It is principally composed of felstone porphyry with various small masses of Lower Silurian stratified rock, some probably caught up in the felstone. The slates of some of these yield graptolites. At Kiln Point, on the shore near the S.E. angle of the Island, there is a mass of thin beds of limestone which contain Bala fossils; they have thin earthy shales between them. The felstone has sent veins and strings into the lowest bed of the limestone; but it has not had much altering effect thereon. The geological interest of this island is increased by the occurrence, near its N.W. point, of a remnant sheet of Old Red Sandstone (?) not more than 50 feet thick. This consists of sandstones above, and a conglomerate below. It extends along the S. side of Broad Bay for a length of nearly one furlong; the beds dipping N. at from 60° to 30°. The base of the conglomerate is well seen; it lies unconformably on the Lower Silurian ash and slates, which, at this place dip S. at about 50°, and must be now inverted. The N. part of this remnant sheet is cut off by an E. and W. fault.

The black slates which occupy the low south-eastern part of *Ireland's Eye*, and which apparently rest unconformably on the Cambrian rocks, most probably belong to this formation.

At a few miles southward of Dublin, the Lower Silurian sets in as the surface formation; it extends thence to Waterford Harbour, except that it is interrupted by the Cambrian and granitic exposures.

The rocks of this Lower Silurian area within the district with which we are now concerned, are unfossiliferous; but in Wicklow, at Slieveroe, near Rathdrum, and in the Co. Wexford, they have yielded various fossils of Bala or Caradoc type. The small exposure of this formation at the Chair of Kildare, twenty-four miles

W. by S. from Dublin, has afforded fossils of the same type. The great probability is that much of the unfossiliferous portion of the formation is of the same age as the fossiliferous, though the lower part of it may be, as some of it certainly is, of Llandeilo age. The general strike of the beds, throughout the area now in question, is N.N.E. and S.S.W.; this obtains on both sides of the granite exposure, the longest axis of which has nearly the same direction. All along the sides of the granite, the rocks are changed into mica slate.

Besides the contemporaneous felstone of Portrane and that of Lambay, already mentioned, there are some sheets of felstone porphyry near Bohernabreena, which are most probably contemporaneous; being interbedded with the Lower Silurian strata. There are also masses of basalt and dolerite at Ballynascorney, which are probably intrusive; though rudely conforming to the strike of the slates, &c. These two places are at the mouth of the interesting valley of Glennasmole, three or four miles S. of Tallaght. We may here mention that, in Wicklow and Wexford, of the long ranges of igneous rocks, whose trend corresponds generally with the strike of the Lower Silurian strata, the felstones are usually contemporaneous, the others principally intrusive.

GRANITE.—As we are following chronological order, we must now turn our attention to the granite, before proceeding to the next sedimentary formation. The granitic exposure of this neighbourhood, which is the largest continuous one in the British Islands, extends from Kingstown, on the north, to near New Ross, in Wexford, on the south, a distance of nearly seventy miles. It has a width of from seven to seventeen miles. It must extend northward from Kingstown, beneath the sea, into Dublin Bay, and probably farther still, as we find the small island Rockabill, five miles off Skerries, and just outside the northern boundary of the map, to be composed of granite of the same type. But of course the Rockabill granite, though evidently belonging to the same mass, may not belong to the same surface exposure thereof; as is the case with the Carnsore granite at the S.E. point of the Co. Wexford. There are some small isolated granite protrusions in the Co. Wicklow, which differ importantly, as to composition, from that with which we are now concerned; these, however, are outside of our present subject.

The age of the granite of the main mass is determinable

within, what may be called, comparatively narrow limits. The facts that the granite has been intruded into the Lower Silurian rocks, and that the slates of that formation have been metamorphosed all along the border of the granite into mica schist, evidently by the action of the granite, show that the intrusion of the granite was later than the formation of those rocks. On the other hand, the facts that, in the Co. Kilkenny, the Old Red Sandstone reposes undisturbedly on the granite and has not been altered thereby, and that its beds sometimes contain a quantity of granitic pebbles and detritus, show that the protrusion of the granite took place before the deposition of those rocks.

The main granite exposure includes the principal mass, with the highest summits, of the S. Dublin, Wicklow, and Wexford hills; while the Silurian rocks form lower ground on each side, with some subordinate hills. This, in connexion with the fact that the general strike of the Lower Silurian rocks is very nearly parallel with the length of the granite exposure, on each side, might, at first sight, give rise to the idea that the granite, while being forced into the Silurian strata, had broken through them, upheaving them and throwing them off on either side, so as to make them dip away in both directions. But what evidence there is on the point bears against this supposition. The granite has nowhere brought up the underlying Cambrian rocks on its flanks; nor has it thus brought up the lower of the Silurian rocks. It is true that the metamorphosed Silurian slates, close along the sides of the granite, usually dip away therefrom, on each side; but notwithstanding this, the Silurian strata on the western side of the granite, though evidently much folded and contorted, seem nevertheless to dip, as a whole, towards the granite; so that the higher beds come against it; and it would appear that in the Co. Wexford, also, on the eastern side, they are the upper beds which border the granite (although it is not so, northward of that, in the Co. Wicklow.) Again there are patches of altered Silurian slates lying on some of the highest parts of the granite hills, including the very summit of Lugnaculliagh itself, 3,039 feet, the highest point of all. It is just at the highest part of the granite, where it has escaped denudation, that we find the schist still lying upon it; while on the other hand, it is just where the valley of the Slaney cuts across the range of the granite hills, and the denudation has been greatest,

that we find the width of the granite exposure to be greatest. All these facts point to the conclusion that the granite protrusion may not have broken through the thick mass of Silurian strata, and that it was brought to the surface by the subsequent denudation, which has wrought parts of it into low ground as about Kingstown, Carlow, St. Mullins, &c.

The granite, as already observed, has metamorphosed the Lower Silurian slates, all along the line of its contact with them, into regular mica schist; the alteration extends from the surface of the granite through a thickness of several hundred feet and dies away gradually. The grit bands in the slates are, as might have been expected, but little changed. The width of the metamorphosed rock, as measured on the surface of the ground, is greater on the east, than on the west side of the granite; which seems to indicate that the bounding surface of the granite descends less steeply beneath the slates on its east, than on its west, side. There seems to be some connection between this fact and that already alluded to, viz., that the small outbursts of granite are on the east and that there are none in the Silurian on the west side of the main granite exposure.

The contact of the granite with the Silurian rocks is strikingly exhibited on the shore of Killiney Bay, at the base of Killiney Hill. It is there seen that the granite has irregularly penetrated the Silurian slates and sent off veins into them; it has also caught up what are clearly separated masses of the slate rock, converting all into mica schist and developing therein stellate crystals of chiastolite. Not far off, on the south side of Rochestown Hill, N. and N.W. of Killiney Park, the granite has forced several narrow tongues into the slates, nearly along the direction of the bedding (see the plan of this in the Geological Survey "Explanations," 112, p. 35).

The Rathmichael relief tank of the Dublin waterworks, on the northern hip of Shankill, was excavated directly on the boundary line of the two formations. The boundary was distinct; but not so much so as at Killiney; and there was a peculiar lumpy, lenticular-nodular structure common to the rocks on each side of the boundary; the greatest extension of the flake lumps being parallel to the surface of separation. At the southward end of the Scalp—a remarkable physical feature to be men-

tioned again—the mica slate can be seen in close proximity to the granite; crystals of chiastolite are to be found in it there also. The contact is seen in some places on the west side also of the granite, but only imperfectly, and not under specially interesting circumstances.

It has been suggested that some of the granite of the main mass may have been produced by extreme metamorphism from the rocks in which it is contained; but the similarity of its composition in different places, as far as is known, seems to throw a very great difficulty in the way of this hypothesis. No doubt, as the granite has acted upon the Silurian rocks with which it has come in contact, these rocks must, in some way or other, have reacted upon the still tractable materials of the unsolidified granite. Probably it is to such reaction that the interesting phenomenon to be seen on the S. slope of Rochestown Hill (a locality already mentioned) is due. In a quarry there, just N. of the garden wall of Killiney Park, it may be observed that the crystals of black mica in the granite are arranged in layers parallel to the bounding surface between the granite and the slates. This is visible for a distance of ten or twelve feet from the boundary, which is very abrupt and definite.

The chemical and mineral composition of this granite has been elaborately investigated by the Rev. Dr. Haughton, F.R.S. For the full results of his analyses and the discussion thereon, the reader is referred to Dr. Haughton's Paper in the *Quart. Journ. Geol. Soc.*, London, vol. xii., 1856; and to the joint Paper, by Professor Jukes and himself, in the *Trans. Royal Irish Academy*, vol. xxiii., 1858.

The analyses show comparatively slight differences in the proportions of the constituents of the rock in different localities The following table gives the mean chemical composition of specimens obtained from eleven generally widely separated places:—

Silica,	72·07
Alumina,	14·81
Peroxide of Iron,	2·22
Lime,	1·63
Magnesia,	0.33
Potash,	5·11
Soda,	2·79
Loss by ignition,	1·09
	100·05

The mineral constituents are (1) Quartz, (2) Orthoclase felspar in distinct crystals, (3) Albite felspar (in paste), (4) White mica (Margarodite), (5) Black mica (Lepidomelane). The quartz, orthoclase, and white mica, are always present in distinct grains; the black mica is not always, but frequently, present along with the white, and in smaller proportion. The orthoclase crystals are sometimes large, making the rock porphyritic. The felspar paste contains much more soda than the orthoclase crystals. This suggested the idea to Sir Robert Kane, Dr. Haughton, and others, that the paste might be partly composed of some other felspar besides orthoclase. None such, however, had been seen in this granite, until Dr. W. H. Stacpoole Westropp detected what seemed to him to be some small crystals of albite in some granite from the neighbourhood of Kingstown. These proved to be really albite on being analysed by Dr. Haughton. Since then, Professor Hull has, by means of the microscope, observed in the paste of this granite, besides orthoclase, a triclinic felspar, which is doubtless albite. (In the Mourne granite the albite, as well as the orthoclase, can be distinguished in every hand specimen.) The white mica of the Leinster granite sometimes becomes *plumose.* At different places about Killiney and at Foxrock, near Carrickmines, it has been found collected into nests, with a beautiful flowing, feathery arrangement. It is believed that this is a speciality of this neighbourhood.

For the accidental minerals occurring in this granite and developed in the Silurian rocks metamorphosed thereby, see the Article on the mineralogy of this district.

The jointing of the granite can be well studied in many places, as about the Killiney Hills, especially in the large, now disused, quarries on Dalkey Hill. Several joint systems of different degrees of importance can sometimes be seen intersecting at the same place. The joint surfaces are almost always very even and smooth, entirely different, as to character, from surfaces of fracture; so that however the joints may be connected with the contraction of the granite in cooling, they are something more than mere planes of splitting. The main joints have generally a marked parallelism, sometimes for considerable distances.

It is principally the primary joints, and rarely the others, that have the slickenside coatings so often to be seen on those surfaces.

It is, of course, quite possible that there may be friction slickensides on planes of dislocation in the granite. There must have been such planes produced during the disturbances after the Carboniferous age, when the granite had been thoroughly solidified, and great friction must have taken place along them; but the slickensides so frequently to be seen in the granite joints of this neighbourhood are, at least as a general rule, most clearly structural and not the result of friction. The slickenside striations of the quartz coating of a joint surface are often accompanied by capillary schorl, the needles or fibres of which are accurately parallel to the slickenside striation and unquestionably form part of the phenomenon. The great majority of the slickenside-bearing joints of a neighbourhood have a very observable nearness of direction with each other; the mean dip of these surfaces is at about 30°, so that the variation in the direction of the planes is only one half that of the strikes of the planes. Moreover, the striations are not only strictly parallel on the same surface, but they very seldom deviate much from the mean direction in their vicinity; showing that their directions have been influenced by some common cause. This can be well seen in many places; of which one of the most easily indicated and accessible is the shore at Sandycove (between Kingstown and Dalkey), from the bottom of Burdett Avenue for some distance eastwards.

The granite is often penetrated by dykes and veins of eurite (which may be called a fine close-grained granite with very little or no mica) and by veins of quartz. These, when they intersect can often be seen to be of different ages; and they are sometimes faulted. The eurite veins may be intrusions of later date than the solidification of the surrounding mass, or they may be only infiltrations into contraction fissures; the quartz veins have been doubtless formed by infiltration.

Occasionally, though apparently very rarely, the granite in this neighbourhood exhibits an obscure concretionary structure. Sometimes a freshly exposed joint surface will show indistinct concentric rings of colour two or three feet in diameter, usually iron staining, which might, at first sight, lead to the supposition that the joint had cut across a concretionary spheroid; but it will usually be manifest on closer inspection that the phenomenon is confined to the joint itself. In some places, as near Mur-

phystown, the outer part of a roundish projection of granite seems to be a slightly separated coat or shell of uniform thickness, which might be removed by wedges. This, also, might be supposed at first sight to be an instance of concentric structure; but it appears to be really in some way the effect of the atmosphere, although the granite is quite sound and undecomposed. (This is well seen on a much larger scale on one of the Mourne granite mountains.)

In some places, owing to the decomposition of the felspar, the granite has, for a depth of several feet, become so rotten that it can be chopped out with a spade; it is then used as "freestone" for sanding kitchen floors. This phenomenon may be sometimes observed at some height on a steep hillside, *e.g.*, above Ticknock, on the west side of the Three-Rock Mountain, as well as on low ground. It seems to be the effect of atmospheric action; a necessary condition being some local peculiarity in the felspar; but what this may be does not seem to have been ascertained.

Disturbance and Denudation.—There is a wide unconformability between the next succeeding formation and the Lower Silurian on which it rests; showing that there was great disturbance and denudation between the completion of the Lower Silurian strata and the commencement ot the deposition of the others; this being the second of which we have evidence in this district. Mr. Jukes thought it probable that the Lower Silurians were already disturbed, to some extent, when the granite came up into them; the intrusion of the granite, if it did not directly cause, was, at least, accompanied by further disturbance of those rocks. At any rate, the great disturbance that actually took place would afford opportunity to the denuding agencies of working very unequally on different parts of the great stratified mass. Whilst in some areas of this district several thousand feet in thickness of the Lower Silurians still remain, in others the ground was bared of all such rocks before the Old Red Sandstone was laid down. This was, almost doubtless, the case where the Limestone lies directly on the Cambrian, as at Howth, and it was inevitably so where the Limestone stretches over the Silurian on to the granite, as it does a few miles S.E. of Dublin. But as the Cambrian floor of the Silurian sea was doubtless irregular in this district, and as the granite

came up irregularly into the Lower Silurian strata, we cannot form any idea what thickness of the latter may have covered those places when the denudation began; though it was probably something considerable. But there is good reason for believing that, near the town of Wexford, the whole thickness of the Lower Silurian formation of this region was stripped off the Cambrian rocks before the deposition of the Old Red Sandstone in that vicinity. The Silurian strata seem to have been there laid down evenly on the surface of the already contorted and denuded Cambrian mass; and it is just in that neighbourhood, alongside of the Cambrian boundary, that we have the clearest evidence of the great thickness of the Silurian rocks, viz., perhaps ten or twelve thousand feet. Some such thickness of Lower Silurian beds must have stretched over the now exposed Cambrians, near at hand, and by far the greater part must have been removed by the denudation of which we are now speaking, as is shown by the remains of the Old Red Sandstone which lie on the Cambrian rocks at a distance of only 1¼ mile from the nearest and lowest Silurian stratum. The re-exposing of the Cambrian rocks nearer Dublin must have been, likewise, chiefly performed by this denudation, though doubtless partly by that to be considered farther on.

The fact that the Old Red Sandstone conglomerates near the granite in Co. Kilkenny and in Co. Waterford contain pebbles of that rock is another proof of the great denudation that had taken place before the deposition of these conglomerates; since, as far as we know, true crystalline granite is formed only under the conditions of very slow cooling and great pressure, that is to say at a considerable depth beneath the surface.

OLD RED SANDSTONE (?)—This may be but the basal or shore beds of the Carboniferous formation. Although there are four, and possibly five, presentations of these rocks in this district, they are all very small. This is on account of the (conformable) overlapping which hereabouts runs through the whole series of Carboniferous strata. The post-Carboniferous larger-scale disturbances were, in this region, comparatively small (though not so in the S. of Ireland); and it was only here and there that the later denudation was able to bring these underlying beds to the surface. No fossils have been found in them.

The largest exposure of these rocks is at Portrane and Donabate, where an upheaval has enabled the subsequent denudation to lay them bare between the Silurian and the Carboniferous Limestone. The whole thickness of these beds in this place does not exceed 350 feet.

There is another outcrop of these strata near Lyons, 14 miles W.S.W. of Dublin, where they have been exposed by the removal of the Limestone, for a very small length and width. The remnant patches of these beds to be seen lying on the upturned edges of the Lower Silurian rocks on Shenick's Island (Skerries) and on Lambay Island have been already mentioned.

Along the base of the cliffs at Balscaddan Bay, on the E. side of Howth Harbour, there is a coarse, brecciated conglomerate of quartz-rock materials, red and yellow stained, which, from its proximity to the Lower Carboniferous Limestone, doubtless belongs to these underlying beds.

Just outside the railway at Blackrock Station there is the still exposed part of a rock, the rest of which has been covered by the railway embankment. It consists of a remarkable firmly compacted pure granite breccia. The granite from which it was formed and the remains of the limestone which must have covered it are both visible close by in the People's Park. But as the latter is Upper Limestone, this breccia cannot belong to, nor lie beneath, the base of the Carboniferous formation which could be overlapped only by Lower Limestone.

Carboniferous Limestone.—This formation is one of the salient features of the geology of Ireland. It extends continuously from the E. to the W. coast of our island, occupying the greater part of the central plain and its ramifications. Its greatest thickness is from 2,500 to 3,000 feet. From want of suitable continuous sections its thickness near Dublin cannot be determined, although the bottom of the formation occurs at Donabate, and the top of it only three miles northward of that, a little beyond Rush.

Lower Limestone Shale.—This consists of dark shales and thin flaggy limestones. It surrounds the exposure of Old Red Sandstone or of basal Carboniferous conglomerate at Donabate and runs thence towards the S.W., along the crest of an anticlinal fold, the whole length of the narrow exposure being seven miles. It contains a small characteristic assemblage of fossils. Its whole thickness does not exceed 200 feet.

Carboniferous Limestone Proper.—This has been separated into three divisions, Lower, Middle, and Upper. The distinction between these, however, is principally lithological and local in character; it cannot be generally carried out. The Middle division seems to be the least constant, and about Dublin the Middle and Upper are not distinguishable. In this district the Lower Limestone is generally a pale grey crystalline limestone, sometimes regularly bedded, sometimes in amorphous masses. The neighbourhood of Dublin, for a radius of several miles, is on the Middle and Upper Limestone which here consist generally of dark, earthy limestone, called calp, interstratified with dark grey shales, and with frequent layers or irregular nodules of chert. This is quarried for building stone and road metal. Occasionally beds of good pale limestone, fit for burning occur therein; these sometimes abound in fossils.

The lower division of the Limestone lies directly on the Cambrian rocks at Howth, and its upper division, which has overlapped its own inferior parts, extends on to the Silurian rocks near Skerries, and on to the Silurian rocks and granite at four miles southward of Dublin.

In the last mentioned vicinity the following remarkable circumstance is to be observed. Over all the district between the Liffey and the foot of the Dublin hills the prevailing dip of the Limestone strata (neglecting slight contortions) seems to be everywhere southwards, or towards the emerging Silurians and the granite. This may be partly explained either by undulations of the beds whose opposite dips happen to be concealed, or by a series of faults running nearly E. and W., which repeat the beds; otherwise it would be necessary to attribute to the black, earthy limestone a thickness greater than the known thickness of the group anywhere else. A similar peculiarity of dip may be observed near the northern extremity of the map. The Upper Limestone beds on the shore S. of Skerries and also two miles inland dip northwards towards the Lower Silurian rocks on which they rest.

The actual contact of the Limestone and Cambrian is visible on the W. shore of the Howth peninsula about 200 yards N. of Bottle Quay. The contact of the Limestone and granite is nowhere exposed; the two are visible about a stone's-throw from each other on the shore at Blackrock in the People's Park. In a Limestone

quarry-pit near Carlow, whence stone was being taken to build a new church, some years ago, the workmen, to their great inconvenience, came down upon the granite.

Sometimes masses of the Limestone rock have been more or less highly dolomitized, so that the bedding sometimes becomes obliterated. Examples occur in Howth harbour, and one mile W. thereof close by the railway, and one mile S. of this latter place, also near Milltown bridge and on the shore S.E. of Malahide, and near Loughshinny. Anthracite, probably of animal origin, or perhaps derived from marine algæ, has been found in the Limestone at Castleknock; and sometimes bed faces are covered with a thin film of black carbonaceous matter.

The Limestone, occasionally, contains large and small fragments of granite, both rounded and angular, sometimes associated with granite sand, as also slabs of mica schist, as near Crumlin and at Milltown. These extraneous masses are sometimes quite isolated in the limestone matrix; as though they had been carried out from the land into comparatively deep water in the Carboniferous sea by some unusual means of transport, as, for instance, by being floated by plants to whose roots they may have been attached. Fragments of (unmetamorphosed) Silurian material are found in some of the Limestone beds at Kilsallaghan and Lispopple, eight miles W. by S. of Portrane. In the ravine of the Delvin river, near the Naul, and on the shore, both near Rush, and near Baldungan, two and a half miles northward thereof, there are beds of conglomerate of which the blocks, pebbles, and fragments, both rounded and angular, and layers of sand are of Silurian origin; these were evidently shore beds.

It seems most probable that the Calp, or dark earthy limestone so prevalent around Dublin, was largely formed of fine mud derived from the black Lower Silurian slates. The small proportion of lime in the Calp may account for the fact that there are, apparently, no underground streams in this vicinity. The percolating water, not being able to dissolve the Calp, could not make subterranean passages, as it has done to such an extent in the Limestone of the W. and S. of Ireland. There is a strong spring of fresh water rising through the sea water in Howth Harbour. This comes doubtless from a subterraneous passage in the Lower Limestone of that locality, which is pure, excepting the very local dolomitization near the spot.

It is very remarkable that the above-mentioned conglomerates near Rush and near Baldungan contain pebbles of Carboniferous limestone. In other places the limestone is thickly interspersed with small, angular fragments of older beds of the same formation; these are very visible when they are of a different shade of colour from the matrix. These facts seem to imply that there were minor, pretty even, upheavals and subsidences during the deposition of the Carboniferous Limestone. and that older beds were uplifted from the sea, and had acquired considerable hardness when later beds were being formed partly from their angular and rolled debris. The phenomenon of lenticular bedding, often to be observed in the Limestone, indicates that there were irregular changes of condition connected with the deposition of the strata.

Upper Shales.—A remnant strip of this formation extends from Baldungan towards the Naul, as indicated near the northern extremity of the map. Its length is nearly ten miles, its mean width about one and a half. The rocks consist of hard, splintery shales, interstratified, in some places, with thin grits and flagstones. They used to be called Coal Measures, that term being applied, in a wide sense, to include, not only the Coal Measures proper, but all the strata between them and the top of the Carboniferous Limestone. They are to be correlated with the Yoredale beds. Only the lower part of the group remains, the thickness being about 500 feet. The overlap above mentioned, still continues into this formation, as can be seen near the Bog of the Ring, where these Upper Shales evidently extend beyond the Limestone, so as to come directly upon the Lower Silurian. Though this formation is properly described as conformable with the Limestone, yet, occasionally, local unconformabilities have been noticed between the contiguous beds of the two series. This is what might have been expected, as the great general subsidence during the Carboniferous age must have been, not only interrupted, but temporarily reversed at the end of the Limestone period. As already mentioned, a similar temporary reversal seems to have taken place during the deposition of the Limestone itself; this being apparently necessary to explain the presence of fragments of earlier beds in the later beds of that formation.

The Upper Shales in this district contain a very characteristic assemblage of fossils. There is a very interesting coast section

across the end of this Upper Shale area, for which see Geological Survey Explanations 102, page 62.

The beds of this formation are in a synclinal basin, as is invariably the case in Ireland, and the low hills which they form are hills of circumdenudation. This brings us to the

Disturbance and Denudation which took place after the completion of the whole of the Carboniferous formation, this being the third of which we have evidence in this district. Although in the western and west-central parts of the Carboniferous Limestone plain of Ireland the beds of that formation extend evenly and almost horizontally over considerable areas, yet elsewhere they have undergone disturbance and contortion. Such has been the case in the district with which we are now more immediately concerned, although by no means to the same extent as in the South of Ireland. In many places the beds have steep local dips. They are interestingly contorted at Loughshinny, three miles S. of Skerries, evidently by horizontal compression, which has produced even reversed faults. They are also strongly contorted in a quarry beside the bridge at Lucan and elsewhere. This disturbance being greater in the S. and S.E. of Ireland, has there produced a general system of cleavage pervading all the rocks from the lowest to the highest. The strike of this cleavage is in the S. about W.S.W. and E.N.E.; in the S.E. it gradually turns to about S.S.W. and N.N.E., and it seems to die away a little outside the southern boundary of the map. This disturbance seems to have been (at least principally) effected at a time earlier than the Permian age; so that if, as seems most probable, no formations later than the Carboniferous were laid down in this district until the Drift period, the denuding agencies had nearly all the long period from that time to the present in which to work their will on the disturbed rocks. However this may be, they have very effectually availed themselves of the opportunities afforded them.

When we consider that the Upper Shales just mentioned, and the overlying beds as far as they remain to us, are seen over the greater part of Ireland, to lie in synclinal basins, and that they are always remnant patches, whose limits are due to denudation and not to the dying-out of the beds, we reasonably conclude that these supra-Limestone beds once extended over a great part of the area now called Ireland, and that they have since been removed by denudation. The country around Dublin

must have had over 2,000 feet of such strata removed in this way, besides some of the underlying Carboniferous Limestone, though generally not very much of this has been eroded, as in this vicinity we are on the Middle and Upper Limestone. Doubtless, at Portrane the denudation has removed the whole thickness of the Carboniferous formation, together with the few hundred feet of the thinning out Old Red Sandstone, if it be such, which once covered the Silurian at that place—probably a thickness of over 4,000 feet altogether.

It is on such considerations that Professor Hull has founded his explanation of the origin of the Scalp, a remarkable gap, three miles W. by N. from Bray, which cuts across a spur ridge from the mass of the Three Rock mountain. The water falls both ways from the Scalp. Professor Hull's suggestion is that that gap was cut by a river which began to flow when the Upper Carboniferous strata still covered the neighbourhood, including the site of the ridge, and which became unable to continue passing through that part of its valley when the general denudation had worn down the softer rocks of the upper part of its course more deeply than it was able to erode its bed through the hard granite and mica slate of the ridge, which was already existing, though doubtless not in its present condition.

Notwithstanding the deposition of Drift which has taken place over so much of this district, and the great accumulation of it in certain places, very little of the denudation of which we have been speaking can have been effected during the Drift period to supply the materials then spread about, since the traces of the general glaciation wrought immediately before the Drift period still remain visible in so many places.

GENERAL GLACIATION.—The signs of the action of the general ice-sheet which once covered Ireland are abundant in the vicinity of Dublin. They consist (1) of rock rounding, smoothing, and striation, and (2) of Boulder Clay, or Lower Boulder Clay, as we may call it, without committing ourselves to the hypothesis that is sometimes implied in that title.

The rock-grinding can be seen in many places on the quartz-rock of Howth, Ireland's Eye, Shankill, and Bray Head, on the Old Red Sandstone conglomerate near Donabate station, on the felstone there beside the railway, on that of Lambay Island, on the granite (generally recently stripped of its drift covering) near Dundrum,

about Foxrock, and Dalkey, on the Killiney Hills, &c. It is often strikingly displayed on limestone freshly bared for quarrying; though, of course, almost immediately removed. There was a very fine example of this in a quarry near Finglas Bridge (the one in which the beds are nearly horizontal). The abrading agent has frequently produced very observable crag-rounding, as distinct from mere surface-rounding, though generally accompanied thereby, as on Ireland's Eye, Shankill, and Bray Head. This phenomenon should be viewed from a sufficient distance—say from half a mile to a mile and a half—and in the afternoon, when the sun is favourably situated for showing the effect, owing to the direction of the glaciation. The highest point at which the striations can be certainly found is on the very summit of Shankill, near the Scalp, 912 feet. Unfortunately the granite hills would not preserve the striations except under special circumstances, otherwise those marks of ice-action would be traceable to much greater heights.

The Lower Boulder Clay is of the usual well-known character. It is generally a very stiff clay containing well rubbed, blunted, and scratched, though sometimes angular, and very rarely rolled, stones and blocks; these are often two feet in length, though they are usually much smaller. Except in the S.E. part of this district the great majority of the stones are limestone, even in places situated some miles from the edge of the limestone ground. As the great ice movement was from the extensive limestone plain, we should naturally expect a preponderance of limestone blocks in the boulder clay; but it is sometimes very surprising that the boulder clay, after having been swept along over two or three miles of granite ground, should have picked up so few granite blocks as it has done. In such cases the largest blocks in the clay belong to the local rock. The upper surfaces of such blocks are sometimes ground, smoothed, and scored in the same manner as the surface of the living rock, and in the same direction.

In the N. and N.W. neighbourhood of Dublin the boulder clay has been left in more or less well-defined ridges, which are quite distinct from the eskers to be mentioned presently, and which we shall call drumlins; these are not only parallel with each other but also with the rock-striation of their immediate

vicinity. It is perfectly certain that it must have been the rock-scoring agent which produced the boulder-clay ridges. Having ascertained this, we can often recognise the course of the flows of the universal ice-sheet by the mere inspection of an accurately shaded map. See the shaded Ordnance inch maps, Nos. 100, 101, 110, and 111. These drumlins are even more strikingly displayed in other parts of Ireland.

The rock-scorings and these ridges show that the great glacial flow from the north-westward was divided not far from Maynooth, evidently by the obstruction of the Dublin and Wicklow Hills; see the glacial map of Ireland in Prof. Hull's Physical Geology and Geography of Ireland, p. 210. Agassiz, when in Dublin in 1840, having seen but little of the glacial phenomena of the neighbourhood, naturally supposed that those hills must have been a centre of glacial dispersion. But it is very interesting and remarkable to find that they were not so, but that they were invaded *ab extra* by a great ice-flow which can be traced backward to the less important hills of Fermanagh. They had, however, afterwards, their own small local glaciers as we shall see presently.

STRATIFIED DRIFT.—Immediately over the Lower Boulder clay, which was clearly the *moraine du fond* of the great ice-flow from the north-westward, comes a deposit of stratified water-arranged and washed gravels and sands. These, which we shall call the Middle Sands and Gravels, extend from the present sea level up to a considerable elevation on the hills. They reach 1,100 feet on the S.E. side of the Three Rock Mountain, 1,300 feet on the W. side of that hill, on the summit of the *col* connecting it with Kilmashogue Mountain, 1,250 feet at $2\frac{1}{4}$ miles W. by S. of the last, and the same elevation at one mile W. of this last on the eastern side of Mount Pelier. The distance between the first and the last mentioned spots is five miles.

These elevated parts of the gravels and sands are as well washed and sorted as those on the low grounds; they moreover consist as largely of foreign materials; although resting at those heights on granite hills they are part of the "limestone gravel." Pieces of flinty chalk and other far-transported stones and fragments of marine shells can be found in them as in the low-lying gravels. The shells found in the gravels of this neighbour-

hood all belong to species now inhabiting the neighbouring seas; they are usually much broken, especially those found at the higher elevations. The highest places at which they have been found are at Ballyedmonduff, 1,000 feet, and at one furlong southward of Caldbeck Castle, on the above mentioned *col* between the Three Rock and Kilmashogue Mountains, 1,250 feet above the sea.

It is most probable that a large proportion of these deposits consists of water-rolled and rearranged materials derived from the Boulder Clay which seems to have suffered denudation and to have been removed in some of those places, at least, where the water-formed gravels lie directly on the rock. The gravels have been piled very irregularly; some valleys contain deep accumulations of it. Some places are bare of it, though situated at lower levels than others not far off which are deeply covered.

There are great collections of this formation in Killakee valley, in Glennasmole (shells), in many places in the valley of the Dargle river from Bray towards Powerscourt Deer Park, in Glencullen, about Enniskerry, &c. There are fine natural sections in many places, especially Killiney Bay (shells) and Balscaddan Bay on the E. side of Howth Harbour (shells), and many good artificial sections in large gravel pits about the neighbourhood.

It is just possible that these gravels may have formerly reached higher elevations than those mentioned and have been washed down again. On the Two Rock Mountain, which might be called the southern and higher part of the Three Rock ditto, stones of two to four inches in diameter, and blocks of extraneous material can be found near the summit at 1,750 feet. There are two blocks of granite on the N.W. side of the Great Sugar Loaf, at the height of 1,480 feet, and several others at 1,300 feet; these are three miles from the nearest granite rock; there are some also on the upper part of Bray Head, five miles from the nearest granite. These may have been transported by floating ice, which agent has, doubtless, dropped the large blocks of (local) granite which may be seen resting on the surface of the above-mentioned elevated gravels of extraneous materials resting on the granite hills. The numerous fragments of chalk-flint and the pieces of Mourne granite that are found in the gravels may have been carried hither by floating ice; they may, however, have been gradually drifted along the coast by the ordinary action of the waves.

Upper Boulder Clay.—Over the generally well-washed and stratified Middle sands and gravels may sometimes be seen a nearly, occasionally quite, unstratified deposit, which we may call the Upper Boulder Clay, without implying thereby that it has been formed in the same way as the Lower Boulder Clay. It is of a looser, more earthy material, and may contain far-travelled stones. But as the nature of this deposit, if it be really a separate one, is obscure, and there is considerable difference of opinion thereanent, and as entering into controversy is outside our present business, we shall pass on to the next.

Eskers.—These seem to be the latest of these drift accumulations. We shall not now go into the difficult and vexed question of their mode of formation. They must be as old as the time of floating ice, as they sometimes have very large transported blocks lying *upon* them, just as the level drift often has. It is sometimes evident that these have not been brought out by denudation, but that they have been dropped on the esker by some agency that did not interfere with the gravel and sand already there; and the only agency that can be suggested is floating ice. The eskers consist of thoroughly well washed and generally stratified materials. Shell fragments have been found in them, but only in one or two instances. As their name implies, they are generally in the form of *ridges,* though they are often but more or less well-defined irregular mounds. There is a good specimen of a ridge esker at Greenhills, a couple of miles W. of Rathfarnham. Its whole length is nearly three miles, and its height from thirty-five to sixty feet. A road runs along the crest of its southern portion, where it is narrower and well-defined, for a length of two and a quarter miles. There is also a ridge esker at a place thence called Esker, on the S. side of the Liffey, six miles W. of Dublin, and there are irregular esker mounds in Stillorgan Park and elsewhere.

Local Glaciation.—This is doubtless the proper place in which to mention the glacial moraines which are to be found among the hills in the neighbourhood of Dublin. It is most probable that those moraines were finally left by the ice, as we now see them, about the time of the formation of the eskers or shortly after that.

Each of the two Loughs Bray (12 miles S. by W. from Dublin) occupies its own division of a laterally double hollow on the N.E. side of Kippure Mountain (granite, 2,473 feet above the sea). The

larger or Lower Lough Bray (elevation 1,225 feet) is dammed in by a glacial moraine, the two arms of which meet at the bottom of the lake and then descend towards the bottom of Glencree valley, near the head of which the lakes are situated. Their lower parts below the lake are covered with numerous large granite blocks, some of which must weigh about 200 tons. That part of the grounds of Lough Bray Cottage which is on the N. side of the lake is on a bank leaning against the hill side; the upper side of this bank falls to the hill side. The lower eastern *end* of the bank is beneath the water of the lake. This is clearly a latero-terminal moraine formed by the glacier when it had shrunk so as to be unable to fill the original moraine bed it had made for itself. (The jointing of the highest part of the precipice is well seen from the ground between the two lakes. In the lower part of the precipice the primary jointing dips inwards, and is as regular as stratification; at the summit it is horizontal.) The small Upper Lough (elevation 1,453 feet) might be considered by some the more interesting, glacially, of the two. It is contained in its own recess which is much less deep than that of the Lower Lake. If we may so express it, the width of the Upper Lake is greater than its length. Its longest axis is parallel to the cliff under which it lies and to the moraine dam. This dam is a well defined bank running all along the lower edge of the lake; at its middle part it rises about 90 feet above the water. It is represented, but without the following small details, on the shaded Ordnance inch map, 121. All along its top runs a small, very distinct, ridge or crest, which looks almost like an artificial bank, and close outside of this, for the S.E. half of its length runs a second parallel but not so regular crest. Several huge blocks of granite are scattered about on this moraine dam; one lies right on the first mentioned crest. Some of these must be 200 tons in weight; the largest (on the outer side of the moraine) measures 28 feet in width at its base, 26 feet in height, with a mean thickness of about 9 feet; it must weigh at least 250 tons. These blocks have, no doubt, come from the cliff on the opposite side of the lake. It is interesting to have this evidence of so great power in so small a glacier. No rock-scoring is to be seen; the rocks being all concealed by the moraine masses, except in the precipices over the lakes.

The hollow enclosing the Powerscourt deer-park seems to have contained a glacier. A little before reaching the Waterfall a bank is passed which might well be the terminal moraine of such glacier. This hollow, however, is at a low level.

Mullaghcleevaun (*i.e.*, Cradle mountain,) so called from the *cradle*, or hollow, containing its small lake is seven miles S.E. of Blesington and eighteen miles W.S.W. from Dublin; it rises 2,783 feet above the sea; the elevation of the lake being 2,244 feet. The damming-in moraine is sufficiently striking to be indicated in the shaded Ordnance inch map, 120.

These corries, or small cirques, like the rest among the Wicklow hills (except the North and the South Prison on Lugnaculliagh) face north-eastward; a usual circumstance with such glacier sites; the reason of which is obvious on consideration.

Pleistocene Mammals.—As the limestone forms plain ground in the neighbourhood of Dublin, with hardly any crag escarpments except in a few stream ravines, there is but little opportunity for the occurrence of caves sufficient to make retreats for the cave animals and to become receptacles of the bones of themselves and their prey. None such, therefore, have been discovered. Bones of bear have, however, been found in Co. Kildare, beside the River Boyne, at about two and a half miles above the bridge of the Midland Railway, 31 miles W. by N. from Dublin. They were embedded in peat or sand four feet below the surface. The skull is now in the Museum of the Royal Irish Academy; the rest of the bones were not preserved, although they were but little decomposed. Dr. Leith Adams considers that the skull is that of a young female of *Ursus spelæus.* In the same place were found many bones of deer.

A remarkable collection of the remains of *Cervus megaceros* has been discovered at Ballybetagh bog, parish of Kiltiernan, eight miles S.S.E. from Dublin. In 1847, whilst a watercourse was being cut through the bog, the heads and antlers, with other bones, of about thirty individuals of this deer were found within a space of 100 by 4 yards in vegetable compost and sand under peat, as also one head of *Cervus tarandus* or reindeer with the horns large and perfect. In 1875 Mr. Richard J. Moss, on further exploration, discovered the remains of about fifty other individuals; and since then Mr. William Williams, naturalist, has

obtained those of twenty-five more, with the horn of a second reindeer. Thus about 105 individuals of *Cervus megaceros* besides those, doubtless many, whose remains have not been exhumed, were buried at this Irish Big Bone Lick. The animals were nearly all males. Remains of this deer were found also in the great accumulation of gravel a little N. of Enniskerry; these, as might have been anticipated, were much decomposed.

Besides the remains of the two reindeer obtained at Ballybetagh, a very fine and perfect skull of this animal, with antlers, was found on the verge of Curragh bog, a couple of miles N.N.W. of Ashbourne, and 13 miles N.W. from Dublin. It is now in the National Museum of Ireland.

Raised Beach.—This can be seen in various places along the neighbouring coast. It is perceptible near Malahide, and on the W. side of Ireland's Eye. It forms the low narrow neck which makes a peninsula of the Hill of Howth. The flat ground extending along the coast from the mouth of the river Tolka to Merrion, and extending inland for some distance along each side of the Liffey and to Donnybrook, belongs to this formation. The remains of it can be seen at one spot, just S. of the mouth of the Shanganagh River, in Killiney Bay. It runs inland up the valley of the Bray river. It forms the Murrough on the near side of the town of Wicklow.

There is difference of opinion respecting this formation, as occurring in this neighbourhood. Some authorities contending that the low raised beach of this neighbourhood corresponds with that which in S.W. Scotland is at the higher level of 25 feet. Others contending that, beside the lower beach of this neighbourhood, there are also traces of a 25-foot beach.

Submarine Peat.—Submarine peat occurs in many places around the east of Ireland. It often contains stumps of trees standing *in situ;* in some places turf is cut therefrom at low spring tides. It is said that peat has been brought up in Killiney Bay on the flukes of anchors. It occurs off the coast of Wicklow and Wexford, sometimes under four fathoms of water. If there be, as just now referred to, two raised beaches in this neighbourhood, this now-submerged peat grew subaerially of course, after the higher and probably before the lower beach was formed. This, if

correct, would indicate the following oscillations of level of the land. The land, having stood for some time while the upper beach was being formed, rose about sixty-five feet, when the now-submerged peat grew upon it; it then subsided a little more than sixty-five feet, and stood until the lower beach was formed; it then rose again, a few feet, to its present level.

RECENT PEAT.—Considerable portions of some of the hills are covered with what is doubtless to be called recent peat. On the summits of some of the hills, *e.g.*, Prince William's Seat, 1,825 feet, it is now being *removed* by atmospheric denudation, which seems to indicate that in such situations the conditions are not now as favourable as formerly for its growth and increase. At the head of Glencree, above the Reformatory, the turf lies on the granite to a depth of from six to twenty feet, and it is said that roots of lime and stems of fir, willow, &c., (the fir is unquestionable), are frequently met with in cutting it there; the elevation above the sea being 1,500 feet. This also seems to indicate some change in atmospheric conditions in such situations; as it is doubtful if trees could grow there now.

List of Places with Geological Phenomena of Special Interest.

Shenick's Island, Skerries. Lower Silurian, &c.

Lough Shinny and coast on each side. Limestone and Upper Shales, strong contortions, reversed fault, fossils.

Malahide shore. Lower Limestone Shale.

Portrane. Lower Silurian limestone, with fossils, &c.

Lambay Island. Lower Silurian limestone with fossils, felstone porphyry, remnant of Old Red Sandstone (?).

Howth Peninsula. Cambrian, numerous igneous dykes. Shell-bearing drift. Isthmus of Raised Beach.

Greenhills, beyond Crumlin. Esker.

Glennasmole. Felstone and basalt outside entrance. Deep shell-bearing Drift within.

Ballyedmonduff and Caldbeck Castle. Shell-bearing drift, 1,000 feet and 1,200 feet.

Blackrock. Nearest visible approach of Limestone to Granite, Granite breccia.

Dalkey. Extensive granite quarries on hill. Granite *roches moutonnées* near town.

Killiney Bay. Junction of Granite and Mica Schist. Shell-bearing drift.

Rochestown Hill. Junction of Granite and Mica Schist, laminated granite. Rock-scoring.

Kiltiernan. Cervus megaceros, C. tarandus.

Ballycorus. Disused mine, Smelting Works.

Scalp. Junction of Granite and Mica Schist. Physical feature.

Lough Bray. Physical feature, Granite jointing, glacial moraines.

Bray Head. Section in Cambrian, Oldhamia, &c. Glaciation.

Greystones. Section in Cambrian, Oldhamia, dyke, glaciation.

ON THE PALÆONTOLOGY OF COUNTY DUBLIN,

BY

WILLIAM HELLIER BAILY, F.G.S.

[Read February 18th, 1878.]

THE fossil-bearing rocks in the vicinity of Dublin, including the adjoining County of Wicklow, belong to the oldest series of formations, being of Cambrian, Silurian and Carboniferous age; with the exception of a few Pleistocene deposits, containing marine shells in gravels of the Glacial period.

The Cambrian fossils first claim our attention, as belonging to the oldest fossiliferous formation of the British Islands. From the Bray railway station, a walk along the shore of about a mile brings us to the commencement of the series of rocks forming Bray Head. Certain beds in the hard, sandy shales and slates may be seen to be covered with impressions and markings which were, evidently, organic; they have been described under the generic name of Oldhamia, after Dr. Oldham, who first made them known. Two species of these remarkable fossils were defined by Professor Forbes: viz., *O. antiqua* and *O. radiata.* He considered them to belong to the Hydrozoa, and to be allied to Sertularian Zoophytes. Others have considered them to be plants, if so, they are most probably Red Algæ, allied to the lime-secreting Corallines. They occur in both green and red or purple slates. On the shore, the best locality for *O. radiata,* is the "Periwinkle Rocks," at Bray Point, only to be reached at low water; the finely laminated green grits at this place being covered with their impressions, and about a mile and a-half further they are plentiful in certain purplish shaly beds, which are interstratified with thicker beds of grit, forming the cliffs rising from the sea at Bray Head, near the "Cable Rock." Good examples of *O. antiqua* may be obtained from red beds near the same place, but more inland, a little above the footpath, round the Head, and just within the boundary-wall of Kilruddery Demesne, also at other places close to the same footpath, in cuttings of the Dublin, Wicklow and Wexford railway, and in various places in the cliffs upon the shore.

Oldhamia antiqua has the appearance of a number of small fan-shaped tufts, arranged in an alternating manner, upon a zigzag axis. This species is also abundant and well preserved in the brown and purple slates of Carrick Mountain, County of Wicklow, accompanied there, as at Bray Head, by tracks and burrows of animals, which frequently occur in pairs, and resemble those from the Cambrian rocks of the Longmynd in Shropshire, named by Mr. Salter *Arenicolites didymus* and *A. sparsus*, species which are probably identical. The late Dr. Kinahan believed he had detected *Oldhamia antiqua*, accompanied by tracks, in brown laminated slates at "Puck's Rocks," near the "Nose of Howth." The specimen he collected, and presented to the Geological Survey Collection, is not, however, so distinct as those from Bray or Carrick Mountain.

Oldhamia radiata.—The most frequent form resembles a number of detached bunches of flattened sea-weed, without any connecting axis or stem, covering irregularly the thin laminæ of the rock, giving it a somewhat star-shaped appearance. This species is most abundant on the shore at Bray and Greystones Co. Wicklow.

Histioderma Hibernica is a fossil from the same rocks at Bray, described by Dr. Kinahan* as "the cast of a tentacled cephalobranchiate sea-worm, not very dissimilar from the common lugworm (*Arenicola*) of our present seas." This fossil is of considerable size; it may be seen occurring as mounds on the surface of a large calcareous bed on the shore, a little south of the Periwinkle Rocks. These mound-like protuberances are about one inch and a-half in diameter, with a central depression from which proceeds a tubular opening of about half-an-inch in diameter, passing vertically through the rock from two to four inches, or even more, sometimes in a tortuous or curved manner. These fossils are entirely confined to Irish strata, excepting the double markings, supposed to be the burrows of sea-worms (annelidan), named by Mr. Salter *Arenicolites didymus* and *A. sparsus*. The *Oldhamia* and *Histioderma* have not been detected in the Cambrian rocks of the Longmynds, or those of North Wales.

Haughtonia pœcila, described by Dr. Kinahan, from red gritty beds, Periwinkle rocks, Bray Point, as an aggregation of the

* Journal of the Geological Society of Dublin, vol. viii., p. 71.

tubes of a gregarious Annelid, allied to Sabella (Jour. Geol. Soc. of Dublin, vol. viii. (1859), p.p. 116-118., figs. 1 and 2), appears to us to be scarcely definite enough to warrant its retention amongst the fossils of this formation.

Figures and more detailed descriptions of these fossils are given in the Journal of the Geological Society of Dublin (*loc. cit.*), the Transactions of the Royal Irish Academy, vol. xxiii. (1858); in the Geological Magazine, 1865, p. 385, &c.; and in the Explanation to sheets 121 and 130 of the maps of the Geological Survey of Ireland; a good series, including some of the figured specimens, being contained in the Geological Survey Collection, Royal College of Science, Dublin.

LIST OF CAMBRIAN FOSSILS.

Plantæ or Hydrozoa.

Oldhamia antiqua (*Forbes*), Bray Head, Carrick Mountain, County Wicklow; Howth, Co. Dublin.

,, radiata (*Forbes*), Bray Head, Greystones, Co. Wicklow.

Histioderma Hibernica (*Kinahan*), Bray Head, Carrick Mountain, Dublin.

Arenicolites didymus (*Salter*) } Probably identical, Bray Head,
,, sparsus (*Salter*) } Carrick Mountain.

LOWER PALÆOZOIC ROCKS, containing Caradoc-Bala species have been observed at several places near Rathdrum, in the County of Wicklow: more particularly at Rathdrum Hill, the Quarry near Rathdrum Bridge, and at Slieveroe. The following is a list of the fossils collected by the Geological Survey in this district:—*

[The prefixed asterisks are intended to represent the comparative abundance of the species.]

ACTINOZOA: *Corals.*

**Favosites fibrosus, branching and hemispherical varieties.

MOLLUSCA: *Brachiopoda.*

Discina perrugata?
Leptæna Griffithiana, new species (*Davidson*).
,, sericea.
Orthis calligramma.
,, elegantula.
Lingula brevis?

* Explanation to sheets 121 and 130 of the maps of the Geological Survey of Ireland, p. 16.

Conchifera.

Modiolopsis and Orthonota, species undetermined.

Nucleobranchiata (Heteropoda).

Bellerophon perturbatus.

ANNULOSA : *Echinodermata.*

Crinoid joints and stems.
Cystidean? plate.
Glyptocrinus ; portion of column.
Palæasterina? starfish.

Annelida.

Tentaculites Anglicus.

CRUSTACEA : *Phyllopoda.*

Beyrichia complicata.

Trilobita.

**Calymene brevicapitata.
Homalonotus bisulcatus?
Lichas laxatus.
*Phacops Brongniarti.
Trinucleus concentricus.

North of Dublin, Lower Silurian fossiliferous rocks of Caradoc-Bala age again appear on the shore at Portrane, and at Lambay Island, County of Dublin; at both these places the lithological character of the rocks, black slates and dark grey limestone, with their contained fossils, are precisely identical. These black slates may be observed on the Portrane shore a little south of the first martello tower from the coastguard station, and on the east side of Lambay Island, north of Kiln Point. From them have been obtained one species of Graptolite, *Diplograpsus pristis*, having a central axis with a double series of cells arranged on either side.

The Silurian limestone is well exposed in prominent cliffs on the Portrane shore, at several places between the first and second martello towers, south of the coastguard station. These rough crags have all the appearance of an ancient coral reef; the chain coral, *Halysites catenularius*, *Heliolites*, *Favosites*, and *Cyathophyllum*, occur in profusion, being weathered out by sea and atmospheric action.

The following list of fossils from these places is derived from the memoirs of the Geological Survey of Ireland [Explanation to sheets 102 and 112., p. 11.] :—

LOWER SILURIAN : fossils ; Portrane, and Lambay, County Dublin.

HYDROZOA : *Graptolites.*

Diplograpsus pristis.

ACTINOZOA : *Corals.*

Cyathophyllum ; species not determined.
*Favosites cristatus.
,, asper.
* ,, fibrosus.
***Halysites catenularius.
**Heliolites interstinctus, and variety megastoma.
*Syringophyllum organum.

MOLLUSCA ; *Polyzoa.*

*Ptilodictya dichotoma.
* ,, acuta.

Brachiopoda.

Atrypa marginalis.
Discina ; species undetermined.
Leptæna quinquecostata.
,, sericea.
,, tenuicincta.
Lingula ; species undetermined.
Orthis biforata.
** ,, calligramma.
** ,, elegantula.
** ,, insularis.
,, porcata.
** ,, testudinaria.
,, vespertilio.
***Strophomena alternata.
* ,, rhomboidalis.
* ,, expansa ?

Conchifera.

Ctenodonta ; species undetermined.
Modiolopsis ; do. do.

Gasteropoda.

*Cyclonema crebristria ?
,, rupestris ?
Euomphalus, two species ; one new, the other undetermined.
*Holopea concinna.
Murchisonia ; two species undetermined
Raphistoma ; new species.

Nucleobranchiata.

Bellerophon subdecussatus.
" new species, allied to acutus.

Cephalopoda.

Orthoceras remotum (*Salter mss.*)
" species undetermined.
" tenuicinctum ?

ANNELIDA.

Tentaculites Anglicus.

CRUSTACEA: *Trilobita.*

Agnostus trinodus.
Æglina mirabilis.
**Calymene obtusa.
*Cheirurus clavifrons.
" bimucronatus.
**Cybele verrucosa.
***Illænus Bowmanii.
Lichas Hibernicus.
" laxatus.
Remopleurides longicostatus.
*Sphærexochus mirus.
Stygina latifrons.
*Trinucleus seticornis.

Lower Silurian rocks, with accompanying fossils, are again exposed still further north of Dublin, on the coast north and south of Balbriggan. To the south, from half a-mile to a mile of Balbriggan, the rocks on shoıe at several places, black or dark grey slates, contain fossils, mostly Graptolites. The single-celled form, *Graptolithus Hisingeri*, occurs in profusion, with *G. tenuis* sparingly, and the double-celled and characteristic form of *Diplograpsus pristis* plentifully. Small orbicular Brachiopods, allied to *Crania*, are occasionally associated with the Graptolites.

About one mile and a-half north of Balbriggan, the rocks on shore near Lowther Lodge and west of the Cardy Rocks, consisting of grey and brown shales, are very fossiliferous; the small coral *Favosites fibrosus*, and Brachiopod shells *Leptæna sericea*, *Orthis calligramma* and *O. porcata*, *Strophomena alternata* and *S. deltoidea* being abundant, with the Trilobites *Cybele verrucosa Calymene brevicapitata*, and a small Phyllopod Crustacean, an undetermined species of *Beyrichia.* This assemblage of fossils indicates strata of Caradoc-Bala age.

N 2

Two other fossil localities, also in Silurian strata, have been observed more inland, one of them being a little south of Stamullin, close to the river Delvin, where a Crinoid head, doubtfully referred to *Glyptocrinus*, and single-celled Graptolites—probably *G. Hisingeri*—were long since obtained by the Geological Survey Collectors, from grey shales and grits. The other is situated about a mile and a-half west of Balbriggan, at an old quarry on the road to Balscaddan, where similar grey shales yielded a few fossils, amongst them *Orthis calligramma* and *Theca triangularis.* *

LOWER SILURIAN fossils; near Balbriggan, Co. Dublin.

HYDROZOA: *Graptolites.*

**Diplograpsus pristis.
***Graptolithus Hisingeri.
,, tenuis.

ACTINOZOA: *Corals.*

**Favosites fibrosus.

MOLLUSCA: *Brachiopoda.*

Crania?
**Leptæna sericea.
Orthis Actoniæ.
* ,, calligramma.
* ,, porcata.
*Strophomena alternata.
* ,, deltoidea.

Pteropoda.

Theca triangularis.

ECHINODERMATA.

Crinoid fragments.
Glyptocrinus?

CRUSTACEA: *Phyllopoda.*

Beyrichia, species undetermined.

Trilobita.

Calymene brevicapitata.
Cybele verrucosa.

CARBONIFEROUS LIMESTONE is the prevailing formation in the immediate neighbourhood of Dublin, and although for the most part covered by drift, is observable at the numerous quarries opened for economical purposes, at coast sections, and Railway cuttings.

Sections of this formation are to be seen on the south of

* Explanation of Sheets 91 and 92, Geological Survey of Ireland, p. 21.

Dublin, between Militown and Clonskea on the banks of the river Dodder, at several places near Rathgar and Rathfarnham, Kimmage, Crumlin, Goldenbridge, &c., Clondalkin and Lucan, all south of the river Liffey; and at Killester railway cutting and quarry, south of Finglas, quarries and cuttings at Blanchardstown, east and south of the village, on the north side of the river Liffey. All these are more or less fossiliferous localities, considered by the officers of the Geological Survey* to belong to the Upper Limestone ("Calp" of Sir Richard Griffiths), although the Palæontological evidence affords no grounds for such division. Quarries at Castleknock a little south of the village, and in the townland of Mitchelstown, three miles N.N.W. of Finglas, at Cloghran, Dunsink, north of Cappoge, the large quarries at Saint Doulagh's, rocks on shore near Howth Lodge, and quarry to the south, near the Deer Park, are all in compact Lower Limestone, usually containing a large assemblage of fossils. At Balscaddan Bay, north of Howth Harbour, are Lower Limestone shales. These lower beds, consisting of dark earthy limestone and shales, are highly fossiliferous. On the shore south-east of Malahide similar strata appear, the low cliffs containing an abundance of corals, crinoids, and Brachiopods. In some beds near the second Martello tower from Malahide, bunches of coral, *Lithodendron junceum,* may be seen attached to a large bivalve shell, *Pleurorhynchus fusiformis;* other beds are full of *Spirifera bisulcata, Athyris planosulcata,* &c.

The old quarries inland—at Seamount, south of Malahide, and Feltrim to the south-west—have furnished a large number of species. Still further north, near the northern boundary of Sheet 102 Geological Survey Map, a little south of Skerries, a large quarry in the Lower Limestone has also yielded many fossils, amongst them being the large and beautiful univalve shell, *Platyschisma* (Turbo) *tiara,* a fossil which has also lately been collected by Captain Bennett, at Howth quarry, and Clare, Co. Kildare.

The following is a list of the quarries and other places in the County of Dublin where Lower Carboniferous Limestone fossils have been observed.† These localities are numbered,

* Explanation of Sheets 102 and 112, Geological Survey of Ireland, 1861, p. 7.
† Ibid, p. 13, &c.

corresponding numbers being placed opposite each species, in order to show where such fossils were collected, without repeating the names of the places where they occurred.

No. of Locality.	Situation and Sheet of Inch Map.
1.	"The Hoare Rock;" one and three-quarter miles west of Garristown; Sheet 101.
2.	Townland of Holmpatrick; rocks on shore, a little north of townland, south of Skerries boundary; Sheet 102.
3.	Oldtown; in the village; Sheet 102.
4.	Townland of Wolganstown; one mile and a-half south-west of Oldtown; Sheet 102.
5.	On the shore, about a furlong W.N.W. of Corballis House; Sheet 102.
6.	Seamount old quarries, about one mile south-east of Malahide; Sheet 102.
7.	Rocks on shore, E.S.E. of Malahide; Sheet 102.
8.	Quarries in the townland of Mitchelstown, three miles N.N.W. of Finglas; Sheet 102.
9.	Quarries at the village of Cloghran; Sheet 102.
10.	Townland of Dunsink; near Blanchardstown, Midland G. W. Railway; several localities near the Observatory; Sheet 102.
11.	Near Cappoge House; Sheet 102.
12.	The large quarries near St. Doulagh's; Sheet 102.
13.	On the shore near Howth Lodge, and quarry near Deer Park, to the south of it; Sheet 112.
14.	Rocks on shore at Balscaddan Bay; Sheet 112.
15.	Townland of Woodlands; near Lucan, several localities; Sheet 111.
16.	Townland of Woodville; E. of Clonsilla; Sheet 111.
17.	Townland of Astagob; a little N.E. of Lucan; Sheet 111.
18.	Quarries, S. of the village of Castleknock; Sheet 112.

List of the species of LOWER CARBONIFEROUS LIMESTONE Fossils, from the above localities.

PLANTÆ.

	Locality No.
Plant stem	7

CŒLENTERATA.

ACTINOZOA.—*Corals.*

	Localities.
Amplexus coralloides, . .	6, 10, 12, 15, 16, 17, 18.
Aulopora gigas, ...	15.
Cyathophyllum Stutchburyi, .	7, 14.
Gorgonia Lonsdaliana, . . .	6,
Lithodendron affinis, . .	13.
,, junceum, . .	6, 7, 14.

	Locality No
Lithostrotion striatum, . .	2.
Michelinea favosa, . . .	14.
Zaphrentis patula, . .	7, 14.
,, Phillipsi, . . .	7, 15, 16.

MOLLUSCA.—*Polyzoa.*

Ceriopora interporosa, . .	14.
,, rhombifera, . .	7.
Fenestella antiqua, . . .	6, 7, 9, 10, 11, 13, 15, 16, 17, 18.
,, membranacea, . .	3, 6, 12, 17.
,, multiporata, . .	15, 18.
,, undulata, . . .	6.
,, varicosa ? . .	15.
Glauconome bipinnata, . .	6, 12.
,, gracilis, . . .	7.
Ichthyorachis Newenhami, .	7.
Polypora fastuosa, . . .	5.
,, verrucosa, . . .	6, 17.
Ptylopora flustriformis, . .	6.
,, pluma, . . .	10.
Vincularia dichotoma, . .	6, 10, 12, 15, 16, 17, 18.
,, multangularis, . .	12, 17.

Brachiopoda.

Athyris ambigua, . . .	6, 7.
,, lamellosa, . . .	7.
,, planosulcata, . . .	10, 15, 18.
,, Royssii, . . .	10.
Chonetes Hardrensis, . . .	8, 10, 15.
,, papilionacea, . .	2.
,, tuberculata, . .	12.
Discina nitida, ...	6.
Lingula mytiloides, . . .	15.
Orthis resupinata, . . .	1, 2, 6, 7, 10, 12, 15, 17, 18.
Productus aculeatus, . . .	3, 5, 6, 8, 9, 10, 12, 15, 17, 18.
,, cora, ...	2. 12, 17, 18.
,, giganteus, . . .	2, 10, 18.
,, longispinus, . .	7.
,, margaritaceus, . .	2, 18.
,, mesolobus, . .	6, 10, 12, 15, 18.
,, plicatilis, . . .	15.
,, punctatus, . .	8.
,, scabriculus, . .	1, 2, 6, 7, 10, 12, 13, 16, 17, 18.

	Locality No.
Productus semireticulatus, .	1, 2, 3, 5, 6, 7, 8, 9, 10, 12, 13, 15, 16, 17.
,, undata, . . .	17, 18.
Retzia radialis ? . . .	6.
Rhynchonella pleurodon, . .	1, 3, 5, 6, 7, 10, 13, 18.
,, pugnus, . .	6, 10, 12, 15, 16.
Spirifera cuspidata, . . .	7.
,, duplicostata, . .	15.
,, glabra, . . .	2, 6, 7, 10, 12, 13, 14, 15, 18.
,, laminosa, . . .	7, 14.
,, lineata, . . .	2, 3, 6, 7, 10, 12, 13, 16, 17, 18.
,, pinguis, . . .	7, 9, 10, 12, 13, 15, 18.
,, rhomboidea ? . .	15.
,, striata, . . .	3, 6, 7, 10, 12, 13, 15, 16, 17, 18.
,, trigonalis, . . .	1, 2, 6, 15.
,, triradialis, . . .	6, 13, 15, 17
Spiriferina cristata, . . .	6.
Streptorhynchus crenistria, . .	6, 7, 10, 12, 13, 15, 17, 18.
Strophomena rhomboidalis, . .	6, 7.
Terebratula hastata, . . .	1, 2, 3, 6, 8, 9, 10, 12, 13, 15, 17, 18.

Conchifera.

Arca semicostata, . . .	15, 16.
Avicula lævigata, . . .	17.
,, lunulata, . . .	6, 12.
Aviculopecten clathratus, . . .	6.
,, concentricostriatus,	6, 18.
,, dissimilis ? . .	13.
,, fallax ? . . .	17.
,, flabellulus, . .	6, 12, 17.
,, flexuosus, . .	3.
,, Forbesii, . .	6, 10, 12, 15.
,, granosus, . .	6, 12, 15.
,, lævigatus, . .	6, 12, 18.
,, planicostatus, .	15.
,, quinquelineatus, .	8.
,, rigida, . . .	6, 18.
,, (Amusium) Sowerbii,	9, 10, 12, 18.
,, tessellatus, . .	6, 12.
Cardiomorpha oblonga, . .	6, 12, 17, 18.
Cucullæa obtusa, . . .	10.
Edmondia quadrata ? . . .	8.
,, sulcata ? . . .	17.

	Locality No.
Edmondia oblonga, . . .	11.
Leda, new species ? . . .	15.
Leptodomus fragilis, . . .	6.
Lima lævigata ?	12.
Lithodomus dactyloides, . .	?6, 15, 18.
? Myacites Omaliana, . .	17.
Pleurorhynchus aliformis, . .	?6, 13.
„ armatus . .	18.
„ fusiformis, .	7, 14.
„ Koninckii, n. s. (Baily) . .	14.
„ Hibernicus, .	6, 18.
Sanguinolites plicatus, . .	6, 10.
Pullastra bistriata, . . .	6, 12.
„ scalaris, . . .	6.

Gasteropoda.

Acroculia neritoides, . . .	17.
„ vetusta . . .	6, 12, 15.
Dentalium ornatum ? . . .	6.
Euomphalus Dionysii, . .	6.
„ pentangulatus, .	6, 7, 10, 12, 15, 18.
„ pileopsideus, . .	6.
„ serpula, . . .	2.
„ tabulatus, . .	6, 15, 18.
Loxonema Lefebvrei, . . .	13.
Macrocheilus ovalis, . . .	10, 15.
„ (Littorina) pusillus,	7.
Natica elliptica, . . .	6, 12.
„ plicistria, . . .	6, 7.
Patella mucronata, . . .	6.
Platyschisma (Turbo) tiara, .	12, 27.
Trochella prisca, . . .	6, 12.
Turritella spiralis, . . .	3.

Nucleobranchiata.

Bellerophon tangentialis, . .	6

Cephalopoda.

Actinoceras giganteum, . .	?12, 13.
Goniatites cyclobus, . . .	4.
„ furcatus, . . .	8, 10, 15, 16.
„ sphæricus, . .	10, 15.
„ „ var. obtusus,	15.
„ „ var. truncatus,	10.
Nautilus biangulatus, . .	12, 18.
„ (Discites) discors, . .	13.
„ dorsalis, . . .	10, 12, 13, 18.

	Locality No.
Orthoceras cinctum, . . .	30.
„ Goldfussianum, . .	10, 12, 15, 16, 17, 18.
„ Steinhauerii, . .	15, 18.

ANNULOSA.—*Echinodermata.*

Actinocrinus, stems, &c., . .	3.
„ polydactylus, .	7.
Crinoidea, species undetermined,	7, 8, 10, 12, 13, 14, 15, 17, 18.
Palæchinus, „ „ .	13.
Platycrinus lævis, . . .	7.
„ pileatus, . . .	15.

Annelida.

Spirorbis globosus, . . .	6.
„ intermedius, . .	6.

Crustacea.

Brachymetopus MacCoyi, . .	15, 18.
Cythere costata, . . .	18.
„ inflata, ...	3.
Entomoconchus Scouleri, . .	10, 12, 18.
Griffithides globiceps, . .	2, 3, 6.
Phillipsia Brongniartii, . .	13.
„ Derbiensis, . . .	2, 13, 15, 16.
„ pustulata, . . .	6, 8, 12, 15, 16, 17 18.

VERTEBRATA.—*Pisces.*

Chomatodus, palatal tooth, . .	2.
Cochliodus ?	7.
Psammodus, palatal teeth, . .	6, 7.

List of Fossil Localities, in UPPER CARBONIFEROUS LIMESTONE, County of Dublin.—(Continued from p. 170.)

19 Townland of Tobergreggan ; three-quarters of a mile south of Garristown, junction beds of Upper Limestone and of coal measures ; Sheet 101.

20. Townland of Westown ; in bed of river Delvin, at Ford of Fine ; Sheet 102.

21. Townland of Balrickard ; quarry by roadside, half-a-mile S. of Bog of the Ring, junction of Upper Limestone and coal measures ; Sheet 102.

22. Townland of Courtlough ; quarry close to road, three-quarters of a mile N.W. of Man-of-War, junction of Upper Limestone and coal measures ; Sheet 102.

23. Townland of Loughshinny; on the shore at the village; Sheet 102.

24. Townland of Lougshinny; on the shore, about a furlong S. of the village, junction of Upper Limestone and coal measures; Sheet 102.
25. Townland of Blanchardstown; quarries and cuttings, E. and S. of the village; Sheet 112.
26. One mile and a-half S.W. of Lucan, by roadside; Sheet 111.
27. Cursis-stream quarry, about two miles east of Lucan; Sheet 111.
28. In stream, a little north of Clondalkin village; Sheet 111.
29. Quarry, between road and Tolka river, a quarter of a mile W. of Finglas Wood bridge; Sheet 112.
30. Townland of Butcher's Arms; one mile W. of Golden Bridge; Sheet 112.
31. Townland of Golden Bridge; quarry near Blackhorse Bridge; Sheet 112.
32. Railway cutting and quarry at Killester; Sheet 112.
33. Quarries, S. of road at Greenoge; Sheet 111.
34. About one mile S.E. of Castle Bagot, two and a-half miles S.W. of Clondalkin; Sheet 111.
35. Road cutting and quarries, S. of Corkagh, about one and a-half miles S. of Clondalkin; Sheet 111.
36. Between Corkagh Mills and Belgard Castle; Sheet 111.
37. Newland's Demesne; about a quarter of a mile N.W. of Belgard Castle; Sheet 111.
38. Townland of Garranstown; about a furlong W. of Kilnamanagh House, and one mile S.E. of Clondalkin; Sheet 112.
39. One field, S.E. of Kilnamanagh House; Sheet 112.
40. Quarries, S. of Mount St. Joseph's Monastery, Clondalkin; Sheet 112.
41. Townland of Bushelloaf; a little E. of last locality; Sheet 112.
42. Quarries, near the Red Cow, one mile E. of Clondalkin; Sheet 112.
43. Boundary of Townlands, near the Red Cow; Sheet 112.
44. Near Ballymount Little, one and a-half miles S.E. of Clondalkin; Sheet 112.
45. Between preceding locality and Air Mount; Sheet 112.
46. Quarries, S.E. of Cromwell's Fort, near Crumlin; Sheet 112.
47. Quarries on both sides of the road, S. of Kimmage; Sheet 112.
48. Old quarries, between the townlands of Green Hills and Limekiln Farm, S.W. of Crumlin; Sheet 112.
49. In river Dodder, at Terenure; an old quarry at Rusina Ville; Sheet 112.
50. Quarries, S.E. of R. C. Chapel, Crumlin; Sheet 112.
51. Quarry, by Methodist Chapel, Donnybrook, E.; Sheet 112.
52. In river Dodder, near Milltown; Sheet 112.
53. Large quarry at West Hampton, N. of Roundtown; Sheet 112.
54. In river Dodder, S. side, near Donnybrook; Sheet 112.
55. Quarry on N. side of river Dodder, opposite cloth mill, Rathmines Great; Sheet 112.

List of FOSSILS from UPPER CARBONIFEROUS LIMESTONE, at the above places.

PLANTÆ.

	Locality No.
Plant stems, ...	*21, *24, 27, 31, 32.

ACTINOZOA.—*Corals.*

Amplexus coralloides, . .	26, 35, 50.
Cladochonus crassus, . . .	24*.
Cyathophyllum, (undetermined species), ...	33, 35, 40, 41, 46, 51, 53.
Lithodendron junceum . .	47.
Lithostrotion striatum, . .	20.

MOLLUSCA.—*Polyzoa.*

Ceriopora rhombifera, . .	24*.
Fenestella antiqua, . . .	11, 23, 24*, 26, 36, 52.
„ membranacea, . .	26.
Polypora fastuosa, . . .	22.
Vincularia dichotoma, . .	22.

Brachiopoda.

Chonetes Hardrensis, . .	24*, 28, 31, 35, 40, 43, 48, 54.
„ papilionacea, . .	35, 36, 37, 40, 41, 43, 44, 45, 46, 52, 53, 54, 55.
Discina nitida, ...	22, 23, 46.
Lingula mytiloides, . . .	33.
Orthis resupinata, . . .	22, 23, 24*, 29, 30, 33, 35, 36, 40, 41, 43, 44, 45, 46, 47, 49, 50, 51, 52, 54, 55.
Productus aculeatus, . . .	35, 40, 43, 45, 46, 50, 54, 55.
„ cora, ...	46.
„ gigantea, . . .	35, 46, 47.
„ longispina, . . .	46, 53.
„ margaritacea, . .	53.
„ punctatus, . . .	43, 45, 48, 54.
„ scabriculus, . .	22, 23, 24*, 26, 33, 34, 35, 36, 40, 41, 42, 45, 46, 54.
„ semireticulatus, . .	20, 22, 23, 24*, 33, 35, 36, 38, 40, 41, 42, 43, 45, 47, 48, 52, 53, 54, 55.

* Junction beds of Upper Limestone and coal measures.

	Locality No.
Rhynchonella pleurodon, . .	22, 23, 24*, 32, 34, 35, 41, 51, 52, 53.
,, pugnus, . .	23.
Spirifera trigonalis, . . .	22, 23, 35, 46, 53.
,, convoluta, . . .	22.
,, glabra, . . .	? 19*, 22, 23, 24*, 33, 38, 41, 43.
,, lineata, . . .	22, 23, 24*, 33, 35, 36, 46, 48, 53, 54, 55.
,, pinguis, . . .	26, 35.
,, striata, . . .	24*.
,, triradialis, . . .	45.
,, insculpta, . . .	24*.
Streptorhynchus crenistria, . .	22, 23, 24*, 36, 39, 41, 44, 46, 47, 53, 55.
Strophomena rhomboidalis, .	23, 24*.
Terebratula hastata, . . .	22, 23, 35, 48, 50, 55.
,, ,, var sacculus,	23.
,, vesicularis, . .	52.
Conchifera.	
Aviculopecten Forbesii, . .	47.
? Donax primigenius, . . .	29.
Lithodomus dactyloides, . .	39.
Posidonomya Becheri, . .	19*, 21*, 22*, 24*, 39.
,, ,, var membranacea, ...	28.
Gasteropoda.	
Euomphalus Dionysii, . .	45.
,, pentangulatus, . .	20, 26.
,, pileopsideus, . .	35, 36, 45, 46, 55.
Loxonema (species undetermined),	36, 42, 45, 55.
Macrocheilus do.,	42, 48.
Natica plicistria, . . .	11.
Pleurotomaria (species undetermined), ...	46, 55.
Turritella spiralis, . . .	45.
,, tenuistriata, . .	23.
Nucleobranchiata.	
Bellerophon hiulcus, . . .	45.
Cephalopoda.	
Goniatites furcatus, . . .	25.
,, sphæricus, . . .	19*, 21*, 22, 24*, 31, 32, 35, 36, 48, 53.
Orthoceras Steinhauerii, . .	16*.
,, (species undetermined)	21*, 22, 28, 29, 41, 48.

ANNULOSA.—*Echinodermata.*

	Locality No.
Archæocidaris Urii (plates), .	24*.
Crinoidal remains, . . .	22, 24*, 26, 28, 29, 32, 34, 36, 40, 41, 42, 44, 45, 46, 48, 49, 51, 52, 53, 54, 55.

CRUSTACEA.

Cythere (species undetermined), .	54.
Griffithides globiceps, . . .	24*, 33, 34, 35, 55.
Phillipsia Brongniartii, . .	34.
„ Derbiensis, . . .	23, 36, 43, 44, 45, 53.
„ pustulata, . . .	20, 35, 40, 46.
„ (species undetermined),	54.

PISCES.

Cochliodus? palatal tooth, . .	46.
Fish scales, ...	35.

What were formerly considered to be lower coal measure shales are in the second edition of the Explanation to sheets 102 and 112 of the Geological Survey of Maps (1875), called "Upper Shales," but as they contain a distinct and characteristic assemblage of fossils corresponding with those of the basal shales of the coal measures of Kilkenny, Queen's County, Tipperary, Limerick and Clare, the original designation is retained. Three distinct patches of these basal shales occur in the north of Dublin, near Garristown, the Naul and Westown, extending east of the "Man-of-War;" a second at Featherbed-lane station, Baldongan; and the third on the sea-shore at Loughshinny, between Rush and Skerries. The shales of these places are, in many instances, full of fossils, mostly marine shells such as *Aviculopecten papyraceus Posidonomya Becheri* and *P. membranacea*, *Goniatites sphæricus* and *Orthoceras Steinhauerii.* With these are occasionally associated fish remains and a few fragmentary stems of fossil plants. At some of the localities junction-beds between these coal measure shales and the limestone may be observed. These junction-beds in the list of species are marked with an asterisk

List of Fossil Localities in Lower Coal Measure Shales.

56. A little north of the village of Garristown.
19. Townland of Tobergreggan ; junction-beds mentioned in previous list.
57. Do., one mile and a-half W.S.W. of Garristown.
58. Townland of Westown ; quarry a little S. of the wood.
59. ,, of Knockbrack ; small quarry in the glen.
60. ,, of Kitchenstown ; in a ditch S. of the road.
61. ,, of Belgee ; quarry a little S. of the cross-roads.
21. ,, of Balrickard ; junction-beds mentioned in previous list.
62. ,, of Courtlough ; quarry close to road about three quarters of a mile N.W. of "Man-of-War ;" upper part coal measures.
24. ,, of Loughshinny ; junction-beds mentioned in previous lists.

List of Fossils from Coal Measure Shales at the Above Places.

Plantæ.

Calamites cannæformis, . . 58.
Plant stems (undetermined), . 58, 59.

Mollusca : *Conchifera.*

Aviculopecten papyraceus, . . 56, 58, 59.
,, variabilis, . . 58, 62.
Lunulicardia (species undetermined), 58.
Posidonomya Becheri, . . 60, 61, 62.
,, membranacea . 56, 57, 58, 59, 62.

Cephalopoda.

Goniatites sphæricus, . . . 56, 57, 58, 59, 61.
Orthoceras Steinhauerii, . . 56, 57.
,, (species undetermined), 56, 57, 58, 62.

Echinodermata.

Crinoidea (stems and joints), . 58, 59.

Crustacea.

Dithyrocaris (species undetermined), 58.

The Secondary and Tertiary Rocks are entirely absent from this district, with the exception of the Pleistocene or Glacial Drift, which extends over the northern portion. Southwards of Malahide this more ancient deposit, called the "Lower Boulder Clay,"* "becomes covered by the sand and gravel deposit which on the higher

* Explanation to sheets 102 and 112, 2nd edition (1875), p. 67.

grounds formed of the granite and slate is alone present." Various observers have described this more recent deposit, which on the eastern summit of Mount Pelier is found at an altitude of 1,235 feet above the sea, and on the western side of the Three Rock Mountain at an elevation of 1,200 feet.

Marine shells of existing species have lately been found by the Rev. Maxwell H. Close, near Caldbeck Castle, on Kilmashogue Mountain, at an elevation of a little over 1,200 feet, from a gravel and sand pit (the "limestone gravel" of Ireland). The following were collected :—*

Fusus ? part of columella.
Cardium echinatum.
Cyprina Islandica.
Venus striatula.
  ,, casina ?
Mactra stultorum, with perforations made by a small shell-boring Annelid.

At Ballyedmonduff, on the S.E. side of the Three Rock Mountain, on the road leading from Stepaside to Glencullen, at an elevation of 1,000 feet, from a similar gravel pit, "chiefly composed of clean stratified gravel and sand," the same gentleman collected the following shells, &c. :—

Trophon muricatus.
Fusus ? part of columella.
Turritella communis.
Ostrea edulis.
Pecten (two species).
Cardium edule.
  ,, echinatum.
Astarte compressa.
  ,, elliptica.
  ,, sulcata.
Cyprina Islandica.
Artemis lincta.
Venus striatula.
  ,, casina.
Lutraria elliptica.
Mactra stultorum ?
Tellina ?
Mya truncata ?
Pholas crispata.
Balanus balanoides and perforations ascribed to a small shell-boring Annelid.

* Journal of the Royal Geological Society of Ireland, vol. iv., part 1., new series, p. 36, etc.

Fragments of shells were also observed at other places on the Dublin Mountains in similar deposits, the particulars of which are described by the Rev. M. H. Close in the article referred to.

Fragments of marine shells have also been collected from coarse sand a little to the east of Glennasmole, Townland of Corrageen, at about 600 feet above the sea level,* and form a conglomerate of drift pebbles, cemented together by Arragonite (Carbonate of Lime) a little south of Fort or Bohernabreena bridge.

At Howth marine shells have been collected and described by Dr. Scouler from the gravel deposits there,† and Dr. Oldham gives a list of others from similar deposits at Killiney, in the County of Dublin, and Bray, County of Wicklow.‡

The following species were identified by Dr. Scouler from Howth:—

Turritella (terebra) communis.
(Turbo littoreus) Littorina littorea (Periwinkle.)
(Nerita littoralis) Littorina littoralis.
Buccinum undatum.
Cardium edule.
Cyprina Islandica.
Pecten varius.

Those named by Dr. Oldham from Killiney, &c., being—

Ostrea edulis.
Tellina solidula.
Pecten opercularis.
Pullastra decussata.
Nucula oblonga.
Astarte (Gairensis) elliptica.
Corbula nucleus ?
Saxicava rugosa.

The only remaining fossils to notice are those of Mammalia, found in Pleistocene deposits of freshwater shell marl immediately below the Peat Bogs.

The great Irish deer, *Megaceros Hibernicus,* so frequently found in these deposits in Ireland, evidently existed formerly in considerable numbers in the neighbourhood of Dublin. Professor Oldham, in a paper read before the Geological Society of Dublin, in 1847,§ records the discovery of the remains of at least thirty

* Journal Geol. Soc. of Dublin, vol. vi., p. 144. † *Ibid*, vol. i., p. 270.
‡ *Ibid*, vol. iii., p. 69. § Journal Geol. Soc. of Dublin, vol. iii. 280 (1848.)

individuals, accompanied by the head and antlers, with other bones of a Rein Deer, *Cervus Tarandus*, in the cutting for a drain at Ballybetagh Bog, Kiltiernan, County Dublin, near the boundary of the counties of Dublin and Wicklow (sheet 121, maps of the Geological Survey of Ireland).

Dr. A. Carte also gives in a paper read before the same Society *—an account of a skull and antlers of a Rein Deer found on the verge of the Curragha Bog, in the parish of Ballymadun, near Ashbourne, County Dublin (sheet 101 Geological Survey Maps). This fine example, now in the Royal Dublin Society's Museum, was found in a very similar deposit to that previously mentioned—namely, imbedded in marl and clay, under a thickness of four or five feet of peat.

From the peculiar shape of the brow antler, which forms a broad vertical plate, centrally situated in front of the head, these specimens are proved to belong to the Caribou, or barren ground variety, now inhabiting America, between the 63rd and 66th degrees of north latitude, in the winter, and migrating to the coasts of the Arctic Sea in summer. It becomes, therefore, very interesting to meet with evidence of the former existence of this variety of the Rein Deer in Ireland.

* Journal Geol. Soc. of Dublin, vol. x., p. 103 (1863-4.)

ON THE MINERALOGY OF THE COUNTIES OF DUBLIN AND WICKLOW.

BY

The Rev. SAMUEL HAUGHTON, M.D., Dublin; D.C.L., Oxon.;
Professor of Geology in the University of Dublin.

[Read March 18, 1878.]

The most convenient method of describing the minerals that occur in these counties, is to state in succession the minerals that are found in each of the several rock formations, referred to by the Rev. Maxwell Close, in his sketch of the Geology of the neighbourhood of Dublin.

1. THE MINERALS OF THE DUBLIN AND WICKLOW GRANITES. These minerals are twofold.

(A) *The Constituent Minerals.*
(B) *The Accidental Minerals.*

(A) *The Constituent Minerals.* The granites of Dublin and Wicklow are quinary, consisting of the following minerals :—

1. Quartz.
2. Orthoclase Feldspar.
3. Albite Feldspar.
4. Margarodite Mica.
5. Lepidomelane Mica.

1. The Constituent *Quartz* is grey, watery, transparent, and has a mean specific gravity = 2·645.

2. The Constituent *Orthoclase Feldspar* is milk white, opaque; and has a mean specific gravity = 2·540.

Its mean chemical composition, taken from seven specimens, of which three were from Dublin localities, and four from Wicklow localities, is as follows :—

Orthoclase (mean of seven Specimens.)

Silica,	64·59	per cent.
Alumina,	18·31	,,
Lime,	0·25	,,
Magnesia,	0·58	,,
Potash,	12·23	,,
Soda,	2·75	,,
Loss by ignition,	0·58	,,
	99.29	

3. The Constituent *Albite Feldspar* has, hitherto, been found in separate crystals, in one locality only (Dalkey); but it enters largely into the composition of the granite rocks.

Its chemical composition is as follows:—

Albite (Dalkey Quarry.)

Silica,	64·70	per cent.
Alumina,	21·80	,,
Potash,	2·84	,,
Soda,	9·78	,,
Fluorspar*	0·80	,,
	99·92	

4. The Constituent *White Mica* (Margarodite) of the granites, often occurs in flat rhombic prisms, or in hexagonal plates, formed from the former by the replacement of the acute angles; the angles of the lozenges are 120° and 60°; and the crystals are Biaxial, the plane of the optic axes tracing the major diameter of the lozenge.

The following measurements of the angle between the optic axes have been recorded:—

1.	Three Rock Mountain,	53° 8′
2.	Glendalough,	70 4
3.	Mount Leinster,	72 18
4.	Lough Dan,	70 0
5.	Glenmalure,	67 11
6.	Poulmounty,	76 15

The average chemical composition of the white mica is as follows:—

Margarodite (Mean of four specimens.)

Silica,	44·58	per cent.
Alumina,	32·13	,,
Iron peroxide,	4·57	,,
Lime,	0·78	,,
Magnesia,	0·76	,,
Potash,	10·67	,,
Soda,	0·95	,,
Loss by ignition,	5·34	,,
	99·78	

The amount of water of crystallisation present in this mineral

* The Albite was found in small crystals, lining cavities in the granite, and encrusting crystals of Orthoclase; and it was associated with similar small crystals of accidental purple fluorspar, from which it was separated with difficulty.

separates it completely from *Muscovite,* of which it is considered by Dana to be an altered variety.

5. The Constituent *Black Mica* (Lepidomelane) of the granites occurs in hexagonal plates, and is Uniaxial. Near Ballyellin, (Co. Carlow) it is found associated with Margarodite in large plates; these plates are formed in about equal parts, of Lepidomelane and Margarodite, which fit into each other at angles of 120°— This fitting is purely mechanical and due to the fact that the angles of the Margarodite lozenges are 60° and 120.° Lepidomelane is essentially an iron-potash mica, and is distinct from Biotite, which is an iron magnesia mica. It is completely decomposed by hydrochloric acid. It has the following chemical composition:—

Black Mica (Lepidomelane.)

Silica, . . .	35·55	per cent.
Alumina, . . .	17.08	,,
Iron peroxide, . . .	23·70	,,
Lime, . . .	0·61	,,
Magnesia, . . .	3·07	,,
Potash, . . .	9·45	,,
Soda, . . .	0·35	,,
Iron protoxide, . . .	3·55	,,
Manganese protoxide,	1·95	,,
Loss by ignition, .	4·30	,,
	99·61	

The granite axis of Leinster runs from Rockabill to Poulmounty, N.N.E. to S.S.W., a distance of 90 miles.

Eleven specimens taken at about equal intervals along this axis gave the following mean chemical composition:—

Average Leinster Granite.

Silica, . . .	72·07	per cent.
Alumina, . . .	14·81	,,
Iron peroxide, . . .	2·25	,,
Lime, . . .	1·63	,,
Magnesia, . . .	0·33	,,
Potash, . . .	5·11	,,
Soda, . . .	2·79	,,
Loss by Ignition, . . .	1·09	,,
	100·08	

From this table, combined with the preceding tables, we obtain

the following simultaneous equations, to determine the per-centages of the constituent minerals in the average granite :—

Let	Q	=	the per-centage of	Quartz.
	O	,,	,,	Orthoclase.
	A	,,	,,	Albite.
	W	,,	,,	White Mica.
	B	,,	,,	Black Mica.

(1) Silica, . . .	7207 =	100 Q +	64·95 O +	64·70 A +	44·58 W +	35·55 B.
(2) Alumina, . .	1481 =	—	18·31 O +	21·80 A +	32·13 W +	17·08 B.
(3) Iron peroxide, . .	225 =	—	—	—	4·57 W +	23·7 B.
(4) Lime, . . .	163 =	—	0·25 O	—	0·78 W +	0·61 B.
(5) Magnesia, . .	33 =	—	0·58 O	—	0·76 W +	3·07 B.
(6) Potash, . . .	511 =	—	12·23 O +	2·84 A +	10·67 W +	9·45 B.
(7) Soda, . . .	279 =	—	2·75 O +	9·87 A +	0·95 W +	0·35 B.
(8) Loss by ignition, .	109 =	—	—	—	5·34 W +	4·30 B.

If we select the four equations containing the largest per-centages, viz—The alumina, potash, soda, and iron peroxide equations, we find after several reductions—

$$A = 18{\cdot}0 + 0{\cdot}156\ W + 0{\cdot}191\ B.$$
$$O = 37{\cdot}65 - 0{\cdot}909\ W - 0{\cdot}819\ B.$$

These equations show the manner in which the two feldspars are related to the two micas.

We find finally—

$$B = 5{\cdot}81 \text{ per cent.}$$
$$W = 19{\cdot}16 \quad ,,$$
$$O = 15{\cdot}44 \quad ,,$$
$$A = 22{\cdot}10 \quad ,,$$

Inserting these values into the last seven equations, we obtain—

—	Observed.	Calculated.	Diff.
Alumina, ...	1481	1476·06	+4·94
Iron peroxide, . . .	225	224·99	+0·01
Lime, ...	163	22·28	+140·72
Magnesia, ...	33	41·27	−8·27
Potash, ...	511	511·45	−0·45
Soda, ...	279	280·64	−1·64
Loss by ignition, . .	109	126·89	−17·89

The agreement between calculation and observation is as close as could be expected; and the errors in the magnesia and loss by ignition, are, doubtless, errors of observation, due to the small magnitudes to be ascertained. The excess in the lime is real, and must be accounted for by the existence of a small quantity of paste, in the form of a silicate of lime.

The quantity of silica required to saturate 140·72 parts of lime is about 351·8 ; from which we infer that the paste amounts to 4.92 per-cent. of the rock.

The mean composition of the Leinster Granite is, therefore, as follows:—

Quartz, . . .	32·57	per cent.
Orthoclase, . . .	15·44	,,
Albite, . . .	22·10	,,
Margarodite, . . .	19·16	,,
Lepidomelane . . .	5·81	,,
Paste (silicate of lime) . .	4·92	,,
	100·00	

(B) *The accidental Minerals* found occasionally in the Dublin and Wicklow Granites are:—

Beryl, . . .	Pale, greenish, opaque crystals. Loc. Dalkey, Killiney, Glenmalure, Glenmacanas.
Spodumene, . .	Long, bent, greenish grey prisms. Loc. Killiney.
*Killinite** (altered *Spodumene*).	Fibrolamellar, light green to brownish yellow, brittle; sp. gr. 2·56. Loc. Killiney.
Schorl, . . .	Black. Loc. Clarinda Park, Kingstown; Dalkey, Three Rock Mountain, Stillorgan, Roundwood, Glenmalure, Poulmounty.
Garnet, . .	Small red and brilliant crystals. Loc. Dalkey, Killiney. Cinnamon colour. Loc. Glenmalure, Kilranelagh.
Fluorspar, . .	Small cubes. Loc. Golden Bridge. Octohedra, lining cavities. Loc. Dalkey Island, Dalkey Quarry.
Apatite, . .	Light green, translucent, hexagonal prisms, with lateral edges replaced. Loc. Three Rock Mountain, Killiney Hill.
Agalmatolite, .	Loc. Dundrum, Luganure.

2. The Minerals of the Metamorphic Slates of Dublin and Wicklow.†

In addition to the Micas and Hornblende forming constituent

* The so-called *Killinite* is an altered *spodumene*, from which the lithia has been washed out by weathering.

† The absence of Garnet, Idocrase, and other lime minerals from the metamorphic slates of Leinster is remarkable and very different from what is observed in Donegal and elsewhere.

elements of the Metamorphic Slates, the following minerals are occasionally found :—

Andalusite, . .	Loc. Lugduff, Douce, Luganure, Glendalough, Glenmalure.
Chiastolite (variety of *Andalusite*),	Loc. Killiney, Aghavanagh, Baltinglass Hill.
Staurotide, . .	Loc. Killiney, Glenmalure.
Hornblende, . .	Radiated. Loc. Killiskey; Crystallized, dark green. Loc. Kilranelagh.
Jasper-agate, . .	Loc. Lambay Island.
Mocha Stone, .	Loc. In pebbles found on the sea-beach, Co. Wicklow.
Zircon, . . .	Loc. Croghan Kinshela.
Gold, . . .	Loc. Croghan Kinshela.
Magnetite, . .	Loc. Croghan Kinshela.
Chlorite, . .	Loc. Glenmacanas; Howth.
Spinel, . . .	Small rolled grains. Loc. Croghan Kinshela.
Platinum, . .	Loc. Croghan Kinshela.
Wood-tin, . .	Loc. Croghan Kinshela.

3. THE MINERALS OF THE CARBONIFEROUS LIMESTONE OF THE CO. DUBLIN.

The Minerals found, occasionally, in the Calp limestone and Lower limestone of the Co. Dublin are few in number. Among them may be mentioned :—

Lydian Stone, .	Calp limestone (*passim*).
Iron Pyrites, .	Well formed crystals, occurring in sheets, lining joints in the Calp limestone.
Asphaltum, . .	Solid, opaque, resinous black lustre, conchoidal fracture. Loc. Castleknock.
Anthraconite, .	Loc. Castleknock.

4. MINERALS FOUND IN THE MINES OF THE COUNTY WICKLOW AND COUNTY DUBLIN.

Iron Pyrites, .	Loc. Sulphur mines, Vale of Avoca.
Fluorspar, . .	Large yellow and pale violet blue cubes. Loc. Glendalough mine.
Schieferspar, .	Loc. Luganure mines.
Barytes, . .	Loc. Killiney Hill; Luganure mine; Glenmalure mine; Clontarf.
Native Silver, .	Loc. Ballycorus mine.
Horn Silver, . .	Loc. Ballycorus mine.

Brown Hœmatite, .	Loc. Glenasplinkeen.
Manganese Oxides,	Loc. Glenasplinkeen; Howth.
Native Copper, .	Loc. Cronebawn; Ballymurtagh.
Copper Pyrites, .	Loc. Cronebawn; Ballymurtagh; Avoca.
Tinstone, . .	Loc. Croghan Kinshela, in small rolled fragments and detached worn crystals.
Carbonate of Lead,	Loc. Luganure mines.
Sulphate of Lead, .	Loc. Luganure; Ballycorus.
Phosphate of Lead,	Loc. Glenmalure.
Galena, . .	Loc. Ballycorus; Luganure; Glendalough.
Blende, . .	Loc. Clontarf; Glenmalure.

CATALOGUE OF THE FLOWERING PLANTS AND FERNS OF DUBLIN AND WICKLOW.

BY

DAVID MOORE, PH.D., F.L.S., AND A. G. MORE, F.L.S.

[Read March 18th, 1878.]

(Arranged in the order of the "London Catalogue," 7th ed. The signs prefixed to the specific names are used to show that the plants are † possibly ‡ probably or * certainly, introduced. The brackets enclose such species as occur close to gardens or cultivation, or are not thoroughly established.)

1. Ranunculaceæ.

Clematis.	
[Vitalba. Linn.]	D. Sandhills at Portrane; a doubtful native. Hedges near Dublin (planted).
Thalictrum.	
minus Linn.	D. Sandhills at Malahide, Baldoyle, etc. W. Coast of Wicklow, in several places, but local.
flavum. Linn.	W. Marshy fields, Murrough of Wicklow.
Anemone.	
nemorosa. Linn.	D. and W. Common.
[apennina. Linn.]	D. Abundant at Delville, Glasnevin. Originally planted.
Adonis.	
[autumnalis. Linn.]	D. Howth. Dundrum. W. Near Enniskerry. Not found for many years in either county.
Ranunculus.	
circinatus. Sibth.	D. Pools and streams. Rare. In the Liffey at Chapelizod and Straffan.
peltatus. Fries.	
b. floribundus. Bab.	D. Near Dublin.
c. penicillatus. Hier.	D. Liffey, near Chapelizod.
trichophyllus. Chaix.	D. and W. Frequent.
Lenormandi. F.Schultz.	D. Near Raheny, etc. W. Frequent.
hederaceus. Linn.	D. and W. Common.
sceleratus. Linn.	D. and W. Not unfrequent.
Flammula. Linn.	D. and W. Very common.
Lingua. Linn.	D. Curragha Bog and Raheny (Irish Flora.) W. Marsh ditches on the Murrough of Wicklow.
auricomus. Linn.	D. and W. Frequent.
acris. Linn.	D. and W. Abundant. The ordinary plant in Ireland is R. tomophyllus of Jordan.
repens. Linn.	D. and W. Abundant.
bulbosus. Linn.	D. and W. Common.

Ranunculus.	
parviflorus. Linn.	D. Milltown. Howth. Greenhills. W. River side at Bray (Wade), where it still grows.
‡arvensis. Linn.	D. Near the "Man-of-War," and Raheny. Corn-fields near Balbriggan. (Templeton MS.)
Ficaria. Linn.	D. and W. Abundant.
Caltha.	
palustris. Linn.	D. and W. Common.
Aquilegia.	
†vulgaris. Linn.	D. At the Waterfall, Leixlip; Knockmaroon Hill. (Ir. Fl.) Hedges near Finglas and Glasnevin.
Delphinium.	
[Ajacis. Reich.]	Portmarnock. Introduced.

3. Nymphæaceæ.

Nymphæa.	
alba. Linn.	D. Royal Canal, etc. Rather rare. W. Not unfrequent in the lakes and streams. Lough Dan, etc.
Nuphar.	
luteum. Sm.	D. and W. Local.

4. Papaveraceæ.

Papaver.	
[somniferum. Linn.]	D. Baldoyle, etc. Near Dublin. Not indigenous.
‡Rhœas. Linn.	D. and W. Frequent, and increasing.
‡dubium. Linn.	D. and W. Not unfrequent.
b. Lecoqui. Lam.	D. Baldoyle.
‡Argemone. Linn.	D. Rush. Kilbarrack. Baldoyle. Cabinteely, etc. Rare. W. Coast near Wicklow.
‡hybridum. Linn.	D. Finglas Quarries. Baldoyle. Rush. Swords. W. Murrough of Wicklow.
Meconopsis.	
cambrica. Vig.	W. Dargle, Powerscourt, and Devil's Glen, Wicklow. Maulin Mountain. (W. Archer.)
Glaucium.	
luteum. Scop.	D. and W. Frequent on the coast.
Chelidonium.	
*majus. Linn.	D. and W. Rare.

4* Fumariaceæ.

Corydalis.	
claviculata. D. C.	W. Very local. Powerscourt. Enniskerry; Kilmartin; Bray Head.

Fumaria.

pallidiflora. Jord.	W. Fassaroe, near Bray. (R. M. B.)
†confusa. Jord.	D. and W. Frequent.
†officinalis. Linn.	D. and W. Frequent.

5. Cruciferæ.

Cakile.	
maritima. Scop.	D. and W. Sandy sea-shore. Common.
Crambe.	
maritima. Linn.	D. Formerly near Malahide, Howth, and Kingstown, and Killiney. Not seen lately.
	W. Murrough of Wicklow. Very rare.
Raphanus.	
‡Raphanistrum. Linn.	D. and W. Frequent.
maritimus. Sm.	D. South side of Howth. W. At Greystones, once gathered near the Railway Station.
Sinapis.	
†arvensis. Linn.	D. and W. Common.
‡alba. Linn.	D. Portmarnock, near Dublin. Rush, Skerries, and Swords. (Ir. Flor.) W. Near Bray, etc. Not unfrequent.
†nigra. Linn.	D. and W. Rare.
Brassica.	
[adpressa. Boiss.]	D. Portmarnock. (H. C. Hart.)
Diplotaxis.	
‡muralis. D. C.	D. Portmarnock and Baldoyle.
Sisymbrium.	
officinale. Scop.	D. and W. Common.
†Sophia. Linn.	D. and. W. Sandy fields near the coast. Frequent.
†Irio. Linn.	D. Near Dublin only. Common about Dublin, Glasnevin, Clontarf, etc.
Alliaria. Scop.	D. and W. Abundant about Dublin ; also near Powerscourt, St. Valerie, near Bray, etc.
Hesperis.	
*matronalis. Linn.	W. Woods near Poolaphouca. Well established in one spot on south side of the Dargle (R.M.B.)
Cheiranthus.	
*Cheiri. Linn.	D. and W. Old walls and ruins.
Cardamine.	
pratensis. Linn.	D. and W. Common.
hirsuta. Linn.	D. and W. Common.
b. sylvatica. Link.	D. and W. Not uncommon.

Arabis.	
Thaliana. Linn.	D. Plentiful on south side of Howth.
hirsuta. Brown.	D. and W. Local and rare.
[Camelina sativa. Linn.	Has occurred at Fassaroe occasionally as a weed of cultivation.
Barbarea.	
vulgaris. Brown.	D. and W. Frequent.
[præcox. Brown.]	D. Well established on a wall at Lucan.
Nasturtium.	
officinale. Brown.	D. and W. Common.
palustre. De Cand.	D. and W. Rather rare.
amphibium. Brown.	W. Murrough of Wicklow.
Armoracia.	
[rusticana. Bab.]	D. and W. Waste Ground. Occasional.
Cochlearia.	
officinalis. Linn.	D. and W. Common.
danica. Linn.	D. and W. Rare.
Draba.	
verna. Linn.	D. and W. Common.
Alyssum.	
[calycinum. Linn.]	D. Portmarnock.
Berteroa.	
[incana. D. C.]	D. Portmarnock.
Thlaspi.	
‡ arvense. Linn.	D. and W. Very rare; introduced with the crops.
Capsella.	
Bursa-pastoris. Moench.	D. and W. Very common.
Lepidium.	
[ruderale. Linn.]	D. North Wall, and near Kilbarrack Church. Not seen for many years.
‡ campestre. Brown.	D. Dundrum and Blanchardstown.
Smithii. Hook.	D. and W. Frequent.
Senebiera.	
‡ didyma. Pers.	D. Very local; occasionally about Dublin.
† Coronopus. Poiret.	D. and W. Local.

6. Resedaceæ.

Reseda.	
†lutea. Linn.	D. Very rare. Chapelizod, Knockmaroon, Rush, Malahide, etc.
Luteola. Linn.	D. and W. Frequent.
[suffruticulosa. Linn.]	Well established at Portmarnock.

8. Violaceæ.

Viola.	
palustris. Linn.	D. and. W. Frequent in hilly and boggy districts.

Viola.

*odorata. Linn.	D. and W. rare, and introduced.
hirta. Linn.	D. Portrane; Portmarnock; Howth; Lambay; Knockmaroon; Phœnix Park.
sylvatica. Fries.	
a. Riviniana. Reich.	D. and W. Common.
b. Reichenbachiana.	D. and W. Frequent.
canina. Fries.	D. Portmarnock and Portrane. W. Murrough of Wicklow.
tricolor. Linn.	D. and W. Frequent.
b. arvensis. Murr.	D. and W. Cultivated land. Not unfrequent.
Curtisii. Forster.	D. Baldoyle, Portmarnock, Portrane; Rush, etc. W. Sandy coast of Wicklow in many places.
lutea. Huds.	D. Hill of Lyons. W. Near Kilbride, on the banks of the King's River.

9. Droseraceæ.

Drosera.

rotundifolia. Linn.	D. and W. Frequent.

10. Polygalaceæ.

Polygala.

vulgaris. Linn.	D. and W. Frequent.
b. depressa Wend.	D. and W. Heaths etc. Common.
c. oxyptera. Reich.	W. Sandhills near Arklow.

12. Caryophyllaceæ.

Saponaria.	D. Along the River Dodder.
*officinalis. Linn.	W. Well established between Bray and Enniskerry, and other places.
Silene.	
inflata. Sm.	D. and W. Frequent.
maritima. With.	D. and W. Common.
[conica. Linn.]	Portmarnock. Very rare, and introduced.
*anglica. Linn.	D. Portmarnock. Introduced.
Lychnis.	
‡vespertina. Sibth.	D. and W. Local and rare.
diurna. Sibth.	D. and W. Frequent.
Flos-cuculi. Linn.	D. and W. Common.
‡Githago. Linn.	D. and W. Frequent.
Cerastium.	
tetrandum. Curt.	D. and W. Sandy ground, near the sea. Frequent.
semidecandrum. Linn.	D. and W. Sand hills on the coast.

Cerastium.		
glomeratum. Thuil.	D. and W.	Common.
triviale. Link.	D. and W.	Common.
arvense. Linn.	D.	Coast of Dublin. Not unfrequent. W. Walls and banks near Greystones.
Stellaria.		
media. Linn.	D. and. W.	Very common.
b. Boreana. Jord.	D. and W.	Sand hills at Portrane and Portmarnock.
Holostea Linn.	D. and W.	Frequent.
glauca. With.	D.	Kelly's Glen. (D.M.). Curragha (Wade). W ? Glencree ? and Murrough of Wicklow ? (D.M.)
graminea. Linn.	D. and W.	Common.
uliginosa. Murr.	D. and W.	Frequent.
Arenaria.		
trinervis. Linn.	D. and W.	Rather rare.
serpyllifolia. Linn.	D. and W.	Frequent.
b. leptoclados. Guss.	D. and W.	Frequent.
Honkeneya.		
peploides. Ehrh.	D. and W.	Frequent.
Sagina.		
maritima. Don.	D. and W.	Frequent.
apetala. Linn.	D. and W.	Frequent.
ciliata. Fries.	D. and W.	Frequent.
procumbens. Linn.	D. and W.	Common.
nodosa. Meyer.	D.	Damp hollows in the sandhills at Portrane and Portmarnock. W. Sandhills of Wicklow.
Spergula.		
‡arvensis. Linn.	D. and W.	Common.
Spergularia.		
neglecta. Kindb.	D. and W.	Common on sea-shore.
marginata. Wahl.	D. and W.	Common in wet salt marshes.
rupicola. Lebel.	D. and W.	Frequent on rocks by the sea.

12. Illecebraceæ.

Scleranthus.	
annuus. Linn.	Local and rare. D. Baldoyle and Howth. W. Murrough of Wicklow.

13. Portulacaceæ.

Montia.		
fontana. Linn.	D. and W.	Common.
b. rivularis. Gm.	Not unfrequent.	

16. Hypericaceæ.

Hypericum.		
Androsæmum. Linn.	D. and W.	Frequent.

Hypericum.
[calycinum. Linn.] Powerscourt, &c., naturalized.
perforatum. Linn. D. and W. Common.
dubium. Leers. W. Powerscourt ? (Mackay); not found lately. Ovoca near the station.
humifusum. Linn. D. and W. Frequent.
pulchrum. Linn. D. and W. Frequent.
hirsutum. Linn. D. Leixlip. Woodlands. Santry. Near Canal, from Dublin to Robertstown.
Elodes. Linn. D. and W. Not unfrequent.

17. Malvaceæ.

Althæa.
[officinalis. Linn.] Near Cabragh, Dublin. (Wade, Rar.) Introduced.
Lavatera.
†arborea. Linn. D. Ireland's Eye. Killiney Hill.
Malva.
moschata. Linn. W. Murrough of Wicklow, and near Enniskerry. Wooden-Bridge. (Ir. Fl.)
sylvestris. Linn. D. and W. Frequent.
rotundifolia. Linn. D. and W. Rather rare.
[borealis. Wallm.] Donnybrook. (M. Dowd.)

19. Linaceæ.

Radiola.
[millegrana. Sm.] D ? Between Dolphin's barn and Crumlin. (Threlkeld.) Not seen by any botanist recently.
Linum.
catharticum. Linn. D. and W. Common.
angustifolium. Hud. D. and W. Very local, and chiefly near the Coast.

20. Geraniaceæ.

Geranium.
sanguineum. Linn. D. Howth. Ireland's Eye. Lambay. Killiney. W. Killencarrig and Bray. (Ir. Flor.)
[pratense. Linn.] Powerscourt Gate at Tinnehinch, and roadside near old Connaught, escaped (R.M.B.)
‡pyrenaicum. Linn. D. and W. Not unfrequent in hedge banks, and by roadsides.
molle. Linn. D. and W. Common.
? pusillum. Linn. D. Near Kilmacanogue, Wicklow. (Flor. Hib.) Not found since.
rotundifolium. Linn. D. Old walls at Glasnevin. Finglas. Ballymun, etc. (Ir. Flor.) Now become very scarce.

Geranium.
- dissectum. Linn. D. and W. Frequent.
- columbinum. Linn. D. Many places near Dublin. W. Murrough of Wicklow.
- lucidum. Linn. D. Feltrim Hill. W. Wood near Newtownmountkennedy and Devil's Glen.
- [striatum. Linn.] Well established along the road between old Connaught and Crinken. (R.M.B.)
- Robertianum. Linn. D. and W. Common.

Erodium.
- cicutarium. L'Herit. D. and W. Frequent.
- †moschatum. L'Herit. D. Howth, &c., Dublin. W. Bray, &c.
- maritimum. Sm. D. Killiney. Howth.

Oxalis.
- Acetosella. Linn. D. and W. Frequent.

21. Ilicaceæ.

Ilex.
- Aquifolium. Linn. D. and W. Frequent.

22. Celastraceæ.

Euonymus.
- europæus. Linn. D. and W. Not unfrequent.

23. Rhamnaceæ.

Rhamnus.
- catharticus. Linn. W. Luggelaw, Hedges on Murrough of Wicklow.
- Frangula. Linn. W. Hedges on Murrough of Wicklow.

24. Sapindaceæ.

Acer.
- *Pseudoplatanus. Linn. D. and W. Frequent, but not native.
- ‡campestre. Linn. Hedges on north side of Dublin. Ballycullen, Glasnevin, and Ballymun.

25. Leguminosæ.

Ulex.
- europæus. Linn. D. and W. Common.
- Gallii. Planch. D. and W. Common.

Sarothamnus.
- scoparius. Koch. D. and W. Frequent.
  - *b.* prostratus. Killiney Hill and Howth. Seems to have been mistaken for Genista tinctoria.

Ononis.
- arvensis. Linn. D. and W. Frequent.

Anthyllis.
- Vulneraria. Linn. D. and W. Chiefly on the coast.

Medicago.

lupulina. Linn.	D.	and W. Abundant.
*sativa. Linn.		Portmarnock. (Flor. Hib.) Plentiful near Rush.
[falcata. Linn.]		Portmarnock. (Flor. Hib.); and still occurs.
[denticulata. Willd]	D.	Between Dolphin's barn and Crumlin, once only.
[maculata. Sibth.]		Between Dolphin's barn and Crumlin, with the former introduced.

Melilotus.

‡officinalis. Willd.	D.	About Rush, Portmarnock, Kilbarrack, Baldoyle, &c., chiefly on the coast. W. At Fassaroe occasionally, R. M. B.

Trigonella.

ornithopodioides. D. C.	D.	Howth, near the lighthouse. Killiney Hill. W. Near the river at Bray and Murrough, and Castle of Wicklow.

Trifolium.

subterraneum. Linn.	W.	North bank of the river at Wicklow.
pratense. Linn.	D.	and W. Common.
medium. Linn.	D.	Slopes of Dublin mountains.
	W.	Near the shore at Rockfield.
arvense. Linn.	D.	and W. Rather rare on the coast.
striatum. Linn.	D.	Abundant on Feltrim Hill. Dundrum.
	W.	Murrough and river side at Wicklow.
scabrum. Linn.	D.	Kilbarrack, Howth, North Bull, &c.
	W.	Along the Murrough of Wicklow.
glomeratum. Linn.	W.	By the river side at Wicklow, with T. subterraneum.
repens. Linn.	D.	and W. Common.
fragiferum. Linn.	D.	and W. Very local, and chiefly on the coast, or along the tidal rivers.
procumbens. Linn.	D.	and W. Frequent.
minus. Relhan.	D.	and W. Common.
filiforme. Linn.	D.	and W. Rather rare.

Lotus.

corniculatus. Linn.	D.	and W. Common.
b. tenuis. Kit.	D.	Cloghran, co. Dublin. (D. Orr.)
major. Scop.	D.	and W. Frequent.

Ornithopus.

perpusillus. Linn.	D.	Near the lighthouse, and other places on the south side of Hill of Howth.

Vicia.

hirsuta. Koch.	D.	Plentiful S.E. side of Howth. W. Not uncommon about Bray (R. M. B.)

Vicia.

‡tetrasperma. Moench.	D.	Very rare. Once found on Knockmaroon Hill.
Cracca. Linn.	D.	and W. Common.
sylvatica. Linn.	D.	Killiney and Ballinascorney. W. Rockfield and Devil's Glen. South side of Dargle (R. M. B.)
Sepium. Linn.	D.	and W. Common.
[sativa. Linn.]		An escape.
angustifolia. Roth.	D.	and W. Frequent on the coast.
lathyroides. Linn.	D.	Clontarf, Baldoyle, Howth.
	W.	Sandhills near the Wicklow lighthouse (D. M.)

Lathyrus.

pratensis. Linn.	D.	and W. Frequent.
palustris. Linn.	W.	Marshy fields at Killoughter, near the Murrough of Wicklow. Not found recently.

Orobus.

tuberosus. Linn.	D.	and W. Frequent.

26. Rosaceæ.

Prunus.

spinosa. Linn.	D.	and W. Common.
[insititia. Linn.]	D.	and W. Occasionally planted in hedges.
‡Avium. Linn.	D.	and W. Frequent in Wicklow and Dublin.
‡Cerasus.	D.	Occasionally in hedges.

Spiraea.

Ulmaria. Linn.	D.	and W. Common.

Agrimonia.

Eupatoria. Linn.	D.	and W. Local.
b. odorata. Mill.	W.	Near Enniskerry.

Poterium.

Sanguisorba. Linn.	D.	Local. Near Dublin. Knockmaroon Hill, Feltrim Hill, Raheny, &c. W. About Fassaroe and in Herbert Road, near Bray (R. M. B.)

Alchemilla.

arvensis. Scop.	D.	and W. Frequent.
vulgaris. Linn.	D.	and W. Rather rare, and local.
alpina. Linn.	W.	Cliffs above Lough Ouler. H. C. Hart.

Potentilla.

Fragariastrum. Ehrh.	D.	and W. Common.
Tormentilla. Sibth.	D.	and W. Common.
reptans. Linn.	D.	and W. Frequent.
anserina. Linn.	D.	and W. Common.

Comarum.
palustre. Linn. D. and W. Local.
Fragaria.
vesca. Linn. D. and W. Frequent.
Rubus.
idaeus. Linn. D. and W. Frequent.
plicatus. W. and N. W. Near Roundwood.
discolor. W. and N. D. and W. Frequent.
macrophyllus.
c. Schlechtendalii. Weihe. W. Wicklow (C.C. Babington.)
rudis. Weihe. W. Wicklow.
corylifolius. Sm. W. Wicklow.
saxatilis. Linn. D. Kelly's Glen. W. River side in the Dargle (Irish Flora.)
Geum.
urbanum. Linn. D. and W. Frequent.
rivale. Linn. D. and W. Local and uncommon. Banks of Liffey. Santry and Kilmere Woods (Ir. Fl.)
Rosa.
spinosissima. Linn. D. and W. Frequent near the sea.
tomentosa. Sm. D. and W. Not common.
b .britannica. Desegl. W. St. Valerie and Dargle (R.M.B.)
canina. Linn. D. and W. Common.
arvensis. Huds. D. and W. Frequent.
Crataegus.
Oxyacantha. Linn. D. and W. Common.
Pyrus.
Aria. Hooker. D. Howth (Wade. Rar.). W. Glencree.
Aucuparia. Gaert. D. and W. Frequent.
‡Malus. Linn. D. and W. Not common, and an escape, or planted.

27. Lythraceæ.

Lythrum.
Salicaria. Linn. D. and W. Common.
Peplis.
Portula. Linn. D. and W. Common.

28. Onagraceæ.

Epilobium.
angustifolium. Linn. W. Among rocks on east side of the Scalp about half way up.
hirsutum. Linn. D. and W. Frequent.
parviflorum. Schreb. D. and W. Common.
montanum. Linn. D. and W. Common.
tetragonum. Linn. D. Carrickmines. (Prof. A. Dickson.)
b. obscurum. Schreb. D. and W. Common.

Epilobium.
palustre. Linn. — D. and W. Common.

[Œnothera.
biennis. Linn. — D. Sparingly at Portmarnock (R.M.B.)]

Circæa.
lutetiana. Linn. — D. and W. Frequent.

28. Haloragaeceæ.

Myriophyllum.
verticillatum. Linn. — D. Near Finglas Bridge, and ditches along the canal. W. Ditches on Murrough of Wicklow.
spicatum. Linn. — D. and W. Frequent in ponds.
alterniflorum. — D. and W. Frequent in boggy places.

Hippuris.
vulgaris. Linn. — D. and W. Frequent.

Callitriche.
verna. Linn. — D. and W. Common.
stagnalis. Scop. — D. and W. Common.
hamulata. Kütz. — W. Lough Dan. (A.G.M.)

30. Grossulariaceæ.

[Ribes.
Grossularia. Linn.
rubrum. Linn.
nigrum. Linn. — The three species occur occasionally as escapes from cultivation near cottages, etc.]

31. Crassulaceæ.

Sedum.
anglicum. Huds. — D. and W. Frequent.
acre. Linn. — D. and W. Abundant.
*reflexum. Linn. — D. Walls near Finglas and Chapelizod, Dublin. (Flor. Hib.)
* rupestre. Huds. — D. Walls between Dundrum and Rathfarnham, Dublin. W. Rocks near the new church, Bray.

Cotyledon.
Umbilicus. Linn. — D. and W. Common.

32. Saxifragaceæ.

Saxifraga.
stellaris. Linn. — D. and W. Dublin and Wicklow Mountains.
tridactylites. Linn. — D. and W. Rare.
granulata. Linn. — D. Kilbarrack, Baldoyle, and Portmarnock. W. Sandhills near Mizen Head.

Chrysosplenium.
oppositifolium. Linn. — D. and W. Frequent.

Parnassia.
palustris. — D. and W. On Sandhills and mountain bogs, not unfrequent.

33. Umbelliferæ.

Hydrocotyle.
vulgaris. Linn. — D. and W. Common.
Sanicula.
europæa. Linn. — D. and W. Frequent.
Eryngium.
maritimum. Linn. — D. and W. Frequent.
Apium.
graveolens. Linn. — D. and W. Common near the sea.
Helosciadium.
nodiflorum. Koch. — D. and W. Common.
inundatum. Koch. — D. and W. Not unfrequent.
Ægopodium.
‡ Podagraria. Linn. — D. Rare. W. St. Valerie, Bray (R.M.B.) Roundwood and near Lough Dan.

Carum.
[Carui. Linn] — Accidentally introduced.
Bunium.
flexuosum. With. — D. and W. Frequent.
Pimpinella.
Saxifraga. Linn. — D. and W. Common.
Sium.
latifolium. Linn. — D. Curragha and Howth (Wade. Rar.)
angustifolium. Linn. — D. Near Finglas; Raheny; Curragha. W. Murrough of Wicklow.

Œnanthe.
fistulosa. Linn. — D. and W. Frequent.
Lachenalii. Gmel. — D. and W. Common in salt-marshes.
crocata. Linn. — D. and W. Frequent.
Phellandrium. Linn. — D. and W. Frequent.
Æthusa.
‡ Cynapium. Linn. — D. and W. Common.
Foeniculum.
‡ vulgare. Gaert. — D. and W. In Wicklow and Dublin; near houses, especially towards the coast.

Crithmum.
maritimum. Linn. — D. and W. Frequent on rocky shores.
Angelica.
sylvestris. Linn. — D. and W. Common.
Pastinaca.
‡ sativa. Linn. — D. Finglas, Ballygall, Beldrummond, Rush, Howth, &c. W. Fields near Murrough of Wicklow.

Heracleum.
Sphondylium. Linn. D. and W. Common.
Daucus.
Carota. Linn. D. and W. Common.
Torilis.
Anthriscus. Gaert. D. and W. Frequent.
nodosa. Gaert. D. and W. Not unfrequent.
Chærophyllum.
Anthriscus. Lam. D. Sandhills at Portrane and Portmarnock, and about Dublin. W Murrough of Wicklow.
sylvestre. Linn. D. and W. Common.
temulum. Linn. D. Coolock. Ballinteer. Raheny. Glasnevin. Donnybrook. Old Connaught. W. Herbert Road, Bray. (R.M.B.
Myrrhis.
*odorata. Scop. D. Orchards and hedges in Dublin. (Wade). Not seen recently.
Scandix.
‡Pecten-Veneris. Linn D. and W. Frequent in cultivated fields.
Conium.
maculatum. Linn. D. and W. Hedges and waste places.
Smyrnium.
‡Olusatrum. Linn. D. and W. Frequent.
Coriandrum.
[sativum. Linn.] Rare, and only as an escape from cultivation.

34. Araliaceæ.

Hedera.
Helix. Linn. D. and W. Common.

35. Cornaceæ.

Cornus. D. Hedges near Coolock. (Ir. Flor.)
*sanguinea. Linn. No doubt planted.

37. Caprifoliaceæ.

Sambucus.
nigra. Linn. D. and W. Frequent.
‡Ebulus. Linn. D. Roadsides towards Carton. A weed in Phœnix Park. W. Powerscourt. (Flor. Hib.) Near the Dargle bridge and roadside near Bray. (R.M.B.)
Viburnum.
Opulus. Linn. D. and W. Frequent.
Lonicera.
Periclymenum. Linn. D. and W. Common.

38. Rubiaceæ.

Rubia.
peregrina. Linn. — D. Killiney. Dalkey. Howth.
Galium.
verum. Linn. — D. and W. Frequent.
erectum. Huds. — D. Very rare. Stagstown. Killiney. and Violet Hill, Glasnevin.
Mollugo. Linn. — D. Between Swords and Skerries. Ballymun. Between Finglas, and Glasnevin. Sandymount. W. Vallombrosa, Bray.
saxatile. Linn. — D. and W. Common on heath and mountains.
palustre. Linn. — D. and W. Common.
[? uliginosum. Linn.] — W ? Not found recently, and probably G. Witheringii was mistaken for it.
Aparine. Linn. — D. and W. Common.
Asperula.
odorata. Linn. — D. and W. Frequent.
Sherardia.
arvensis. Linn. — D. and W. Frequent.

39. Valerianaceæ.

Centranthus.
[ruber. D.C.] — D. Quarries near Leixlip, and at Howth. Walls at Glasnevin, Clontarf, Cabra, Lucan (Irish Flora).
Valeriana.
officinalis. Linn. — D. and W. Frequent.
Valerianella.
olitoria. Vahl. — D. and W. Frequent.
†dentata. Koch. — D. Feltrim Hill. Baldoyle. W. Bray.

40. Dipsaceæ.

Dipsacus.
sylvestris. Linn. — D. Rare. Raheny. Cardiff's Bridge. Banks of Tolka. Raheny. Kilbarrack. Clontarf. Swords, etc.
Scabiosa.
succisa. Linn. — D. and W. Common.
arvensis. Linn. — D. and W. Frequent.

41. Compositæ.

Silybum.
*Marianum. Gaert. — D. Kilbarrack and Portmarnock, &c. W. Very rare on the coast, near Wicklow.
Carduus.
tenuiflorus. Curt. — D. and W. Frequent, especially near the coast.

Carduus.
- crispus. Linn. — D. Rare, about Dublin and northwards.
- lanceolatus. Linn. — D. and W. Common.
- palustris. Linn. — D. and W. Common.
- pratensis. Huds. — D. About Marley. (Irish Flora.) W. Glencree and about Loughs Bray and Dan.
- arvensis. Curtis. — D. and W. Common.

Carlina.
- vulgaris. Linn. — D. and W. Frequent, especially on coast.

Arctium.
- minus. Schkuhr.
  - *b.* intermedium. Lange. — D. and W. Frequent.

Centaurea.
- nigra. Linn. — D. and W. Common.
- Scabiosa. Linn. — D. Rare. Rush. Chapelizod. Lucan. Finglas. Glasnevin, Santry, &c. W. Herbert Road, Bray. (R.M.B.) Greystones and Kilcool.
- *Cyanus. Linn. — D. and W. Rather rare.
- [solstitialis. Linn.] — Portmarnock and Clontarf. (Flor. Hib.)
- [paniculata. Linn.] — A single plant near Rush. (M. Dowd.)

Chrysanthemum.
- ‡Segetum. Linn. — D. and W. Frequent, especially on sand.
- Leucanthemum. Linn. — D. and W. Common.

Matricaria.
- [Parthenium. Linn.] — An escape from cultivation.
- inodora. Linn. — D. and W. Common.
  - *b.* maritima. Linn. — D. and W. Common.
- ‡Chamomilla. Linn. — D. Very rare. Raheny and Greenogue (Irish Flora). Doubtful.

Tanacetum.
- *vulgare. Linn. — D. and W. Not common. An escape.

Anthemis.
- ‡Cotula. Linn. — D. and W. Rather rare.
- ‡arvensis. Linn. — D. Rare. Phœnix Park. Lyons. Dublin. Portmarnock.
- nobilis. Linn. — W. On Knock Cree, near Lough Bray. (Ir. Flor.) Rocky Valley, Enniskerry.

Achillea.
- Millefolium. Linn. — D. and W. Common.
- Ptarmica. Linn. — D. and W. Local and rather rare.

Artemisia.
- *Absinthium. Linn. — D. and W. Rare, and introduced.
- †vulgaris. Linn. — D. and W. Frequent.
- maritima. Linn. — D. Very rare. Killiney. Howth. Shore near Portrane House.

Filago.
- germanica. Linn. — D. and W. Common.

Filago.	
minima. Fries.	W. Rare. Murrough of Wicklow. Between Enniskerry and Lough Bray. Dargle. Drumgoff, etc.
Gnaphalium.	
uliginosum. Linn.	D. and W. Common.
sylvaticum. Linn.	W. Powerscourt. Rocky Valley, near Sugarloaf Mountain (R. M. B.) Near Shillelagh (H. C. Hart.)
dioicum. Linn.	D. and W. Rather rare. Chiefly on the coast and mountains.
Senecio.	
vulgaris. Linn.	D. and W. Common.
sylvaticus. Linn.	D. and W. Frequent.
†viscosus. Linn.	D. Very rare. Sutton side of Howth.
erucifolius. Linn.	D. Many places near Dublin. W. Near Bray and Kilrudderry.
Jacobæa. Linn.	D. and W. Common. The rayless variety is frequent on sand-hills towards Drogheda.
aquaticus. Huds.	D. and W. Common.
[saracenicus. Linn.]	Near Clonskeagh, Dublin. Introduced.
Bidens.	
cernua. Linn.	D. and W. Occasionally, in muddy bogs.
tripartita. Linn.	D. and W. Ditto. Both rare.
Inula.	
*Helenium. Linn.	W. Whaley Abbey, Wicklow.
crithmoides. Linn.	D. Killiney Hill. Dalkey Island. Howth. Lambay.
dysenterica. Linn.	D. and W. Frequent.
Bellis.	
perennis. Linn.	D. and W. Common.
Erigeron.	
acris. Linn.	D. Rare. Finglas quarries. Templeogue. Clonsilla. Lucan, Howth, etc. W. Between Enniskerry and Lough Bray.
Aster.	
Tripolium. Linn.	D. and W. Common.
Solidago.	
Virgaurea. Linn.	D. and W. Frequent.
b. cambrica. Huds.	D. and W. Rare. On the mountains.
Tussilago.	
Farfara. Linn.	D. and W. Common.
Petasites.	
vulgaris. Desf.	D. and W. Frequent.
[fragrans. Presl.]	Becoming naturalized.

Eupatorium.		
cannabinum. Linn.	D. and W.	Rather rare.
Cichorium.		
‡Intybus. Linn.	D. and W.	Chiefly on sand-hills along the coast, in Dublin and Wicklow.
Lapsana.		
communis. Linn.	D. and W.	Frequent.
Hypochœris.		
radicata. Linn.	D. and W.	Common.
Leontodon.		
hirtus. Linn.	D. and W.	Frequent on the coast, rare inland.
hispidus. Linn.	D.	Portmarnock (Mackay). Near Santry (D. Orr). Lucan (A. G. M.) Finglas (D. Orr.)
	W.	Murrough of Wicklow (D. M.)
autumnalis. Linn.	D. and W.	Common.
Picris.		
[hieracioides. Linn.]		Portmarnock. (Flor. Hib.) Introduced, and not found for many years.
Helminthia.		
echioides. Gaert.	D.	Howth, etc. Chiefly north and east of Dublin. Rare.
Tragopogon.		
pratensis. Linn.	D. and W.	Rather rare.
Taraxacum.		
officinale. Wigg.	D. and W.	Common.
Lactuca.		
muralis. Fresen.	W.	Very rare. Roadside, from Lara Barracks to Clara.
Sonchus.		
oleraceus. Linn.	D. and W.	Common.
b. asper. Hoffm.	D. and W.	Frequent.
†arvensis. Linn.	D. and W.	Common in cultivated land.
Crepis.		
*taraxacifolia. Thuil.	D. and W.	Baldoyle. Howth. Dublin. Bray, etc.; spreading along the railways.
virens. Linn.	D. and W.	Common.
paludosa. Moench.	D. and W.	Frequent in hilly districts.
Hieracium.		
Pilosella. Linn.	D. and W.	Frequent.
vulgatum. Fries.	D.	Leixlip. W. Powerscourt. Devil's Glen, and Dargle River.
gothicum. Fries.	W.	Glenmalure, Wicklow.
strictum. Fries.	W.	Glenmalure, Wicklow.
umbellatum. Linn.	W.	Glencree. Devil's Glen. Ballyarthur.
corymbosum. Fries.	W.	Glenmalure.

Hieracium.	
boreale. Fries.	W. Glenmalure. Glendalough, and Devil's Glen.

42. Campanulaceæ.

Lobelia.	
Dortmanna. Linn.	W. Glendalough. Loch Dan. Lower Lough Bray.
Jasione.	
montana. Linn.	D. and W. Frequent.
Campanula.	
*Trachelium. Linn.	D. Near Glasnevin. Introduced. W. Roundwood. Do.
*rapunculoides. Linn.	W. Wall near Bray Harbour. Murrough of Wicklow.
rotundifolia. Linn.	D. and W. Frequent.
Wahlenbergia.	
hederacea. Reich.	D. Glencullen. W. Base of Sugarloaf. Glencree. Enniskerry.

43. Ericaceæ.

Vaccinium.	
Oxycoccos. Linn.	D. and W. Rare. On the mountains.
Vitis-idæa. Linn.	W. Upper Lough Bray. Luggelaw. Lugnaquilla. Lug-duff.
Myrtillus. Linn.	D. and W. Common.
Andromeda.	
polifolia. Linn.	D. Bogs along the Military-road from Roebuck to Lough Bray. (Irish Flora.) W. Between Djouce and Luggelaw. (R. M. B.) Side of Kippure. (H. C. Hart.)
Erica.	
Tetralix. Linn.	D. and W. Common.
cinerea. Linn.	D. and W. Common.
Calluna.	
vulgaris. Salisb.	D. and W. Common.
Pyrola.	
minor. Linn.	W. Vale of Ovoca, near "Meeting of the Waters."

44. Jasminaceæ.

Fraxinus.	
excelsior. Linn.	D. and W. Common.
*Ligustrum.	
vulgare. Linn.	D. and W. Frequent, but planted.

45. Apocynaceæ.

Vinca.
[*major. Linn.]
[*minor. Linn.] Both species occur occasionally escaped from cultivation.

46. Gentianaceæ.

Erythræa.
Centaurium. Pers. D. and W. Frequent.
b. pseudo-latifolium. D. Portmarnock sands, &c.
pulchella. Fries. D. North Bull, Dublin.
Chlora.
perfoliata. Linn. D. and W. Frequent, but local.
Gentiana.
Amarella, Linn. D. and W. Rather local.
campestris. Linn. D. W. Frequent.
Menyanthes.
trifoliata. Linn. D. and W. Frequent.
Villarsia.
[nymphæoides. Link.] Naturalized in the River Tolka at Glasnevin.

47. Polemoniaceæ.

Polemonium.
[caeruleum. Linn.] Knockmaroon Hill, near Dublin. (Flor. Hib.) Not indigenous, and not seen lately.

48. Convolvulaceæ.

Convolvulus.
arvensis. Linn. D. and W. Unfrequent.
Sepium. Linn. D. and W. Frequent.
Soldanella. Linn. D. and W. Frequent.
Cuscuta.
Epilinum. Weihe. D. and W. In cultivated flax. Rare.
*Trifolii. Bab. D. Ballybrack. W. Fassaroe, &c., near Bray. Thoroughly established for many years, on other plants besides clover (R.M.B.)

49. Solanaceæ.

Solanum.
Dulcamara. Linn. D. and W. Frequent.
†nigrum. Linn. D. Waste places near Dublin. Very rare. W. Near Wicklow (Hon. Miss Ruthven).
Atropa.
[Belladonna.] D. Formerly at Dundrum (Rutty). Near Blessington-street (Irish Flora). Not seen recently.
Hyoscyamus.
niger. Linn. D. and W. Rare, and chiefly on coast. On Murrough of Wicklow, &c.

50. Scrophulariaceæ.

Verbascum.		
Thapsus. Linn.	D.	and W. Frequent.
[Blattaria. Linn.]		A few plants near Wicklow.
Scrophularia.		
Balbisii. Hornem.	D.	and W. Rather local.
nodosa. Linn.	D.	and W. Frequent.
Digitalis.		
purpurea. Linn.	D.	and W. Frequent.
Antirrhinum.		
‡Orontium. Linn.	D.	Near Dundrum, Dublin (D. Orr).
[majus. Linn.]		Naturalized.
Linaria.		
[Cymbalaria. Mull.]		Naturalized. On garden walls, etc.
repens. Mull.	D.	In Bushy Park, near Rathfarnham Bridge.
vulgaris. Mull.	D.	Baldoyle and Knockmaroon Hill. W. Murrough of Wicklow.
minor. Desb.	D.	Stillorgan and Sidney Parade, and along the M. G. W. Railway near Dublin.
Mimulus.		
[luteus. Linn.]	W.	Plentiful in the river, near Enniskerry.
Veronica.		
hederifolia. Linn.	D.	and W. Common.
polita. Fries.	D.	and W. Common.
agrestis. Linn.	D.	and W. Common.
*Buxbaumii. Pers.	D.	and W. Dublin and Wicklow. An introduced weed, and increasing.
arvensis. Linn.	D.	and W. Common.
serpyllifolia. Linn.	D.	and W. Common.
officinalis. Linn.	D.	and W. Frequent.
Chamædrys. Linn.	D.	and W. Common.
montana. Linn.	D.	Abundant near Dublin. W. Powerscourt, &c., frequent in Wicklow.
scutellata. Linn.	D.	and W. Frequent.
Anagallis. Linn.	D.	and W. Frequent.
Beccabunga. Linn.	D.	and W. Common.
Euphrasia.		
officinalis. Linn.	D.	and W. Common.
Bartsia.		
Odontites. Hud.	D.	and W. Frequent.
Pedicularis.		
palustris. Linn.	D.	and W. Frequent.
sylvatica. Linn.	D.	and W. Frequent.
Rhinanthus.		
Crista-galli. Linn.	D.	and W. Frequent.

Melampyrum.
pratense. Linn. D. and W. Frequent.
b. montanum. Johnst. W. Great Sugarloaf, Wicklow

51. Orobanchaceæ.

Lathræa.
Squamaria. Linn. D. and W. Local, and rare.
Orobanche.
major. Linn. W. Luggelaw and Lough Dan, Devil's Glen, Glen of Downs, Seven Churches. Between Rathdrum and Lara; Kilbride.
Hederæ. Duby. D. Palmerstown, Woodlands, Leixlip, Howth, and Kingstown. W. Glen of the Downs, east side (R.M.B.)

52. Verbenaceæ.

Verbena.
*officinalis. Linn. D. and W. Local and rare, and probably outcast from gardens.

53. Labiatæ.

Lycopus.
Europæus. Linn. D. Rare and local. W. Not unfrequent.
Mentha.
‡rotundifolia. Linn. D. Near Castle Kelly. W. At Glendalough, and Roundwood. Near Enniskerry, an escape (R.M.B.)
hirsuta. Linn. D. and W. Very common.
‡sativa. Linn. }
b. ‡rubra. Sm. } W. Glen of the Downs. Enniskerry river.
arvensis. Linn. D. and W. Frequent.
b. agrests. Not unfrequent.
Pulegium. Linn. W. Base of Great Sugarloaf.
Thymus.
Serpyllum. Fries. D. and W. Common.
Origanum.
vulgare. Linn. D. and W. Rather local.
Calamintha.
[Clinopodium. Benth.] W. Said to have been found between Enniskerry and Bray, but C. menthifolia was probably mistaken for it.
‡Acinos. Clairv. D. Portmarnock. W. Murrough of Wicklow. A few plants near Tulla Church, Carrickmines.
menthifolia. Host. D. Several places. Strawberry beds, &c. W. Plentiful between Enniskerry and Bray, &c.

Nepeta.	
†Cataria. Linn.	D. Banks of Dodder above Rathfarnham. (Flor. Hib.) Sandy fields about Rush and Skerries (Irish Flora.)
Glechoma. Benth.	Common.
Salvia.	
Verbenaca. Linn.	D. Many places near Dublin. W. Murrough of Wicklow.
Prunella.	
vulgaris. Linn.	D. and W. Frequent.
Scutellaria.	
[galericulata. Linn.]	D. Marshes at Howth (Wade Rar.)
minor. Linn.	W. Glenmalure, Rathdrum, and near Lough Bray and Roundwood.
Marrubium.	
†vulgare. Linn.	D. Churchyard at Howth (Flor. Hib.) W. Coast of Wicklow; Bray; and Loughlinstown.
Ballota.	
nigra. Linn.	D. and W. Rather rare.
Stachys.	
Betonica. Benth.	D. Near Abbotstown (Wade Rar.) Not found recently.
palustris. Linn.	D. and W. Common.
ambigua. Sm.	D. and W. Rare.
sylvatica. Linn.	D. and W. Frequent.
‡arvensis. Linn.	W. Shillelagh, and railway banks near Wicklow.
Galeopsis.	
‡Ladanum. Linn.	D. Dundrum; Templeogue, and along the Dodder near Dublin. Malahide; Knockmaroon; Cardiffi Bridge. W. Greystones and Bray. Often plentiful at Fassaroe (R.M.B.)
[versicolor. Curt.	Near Glasnevin formerly. Mackay Cat.]
Tetrahit. Linn.	D. and W. Common.
Leonurus.	
[Cardiaca. Linn.]	Roper's Rest, Dublin (Threlkeld). About Rush and Skerries (Ir. Fl.)
Lamium.	
amplexicaule. Linn.	D. Not unfrequent about Dublin. W. Bray Commons (R.M.B.) Abundant on Murrough of Wicklow.
incisum. Willd.	D. and W. Rare.
purpureum. Linn.	D. and W. Common.
†album. Linn.	D. and W. and near houses. Local.
Galeobdolon. Crantz.	D. Several localities near Dublin; Leixlip; Finglas; Woodlands; Kelly's Glen. W. Dargle and Powerscourt woods.

Ajuga.	
reptans. Linn.	D. and W. Frequent.
Teucrium.	
[Chamædrys. Linn.]	D. Greenhills, near Tallaght (Wade, Rar.)
Scorodonia. Linn.	D. and W. Common.

54. Boraginaceæ.

Echium.	
†vulgare. Linn.	D. Portmarnock, near Skerries and Balbriggan. W. Railway banks near Wicklow.
Mertensia.	
maritima. Don.	D. Shore at Hampton Bank, near Balbriggan, and at Loughshinny, between the two lime kilns. (Wade.) W. Kilcool, on the Murrough. Sparingly.
Lithospermum.	
officinale. Linn.	D. Rare. Several localities near Dublin. W. Bray and Murrough of Wicklow.
‡arvense. Linn.	D. and W. Rather local, and rare.
Myosotis.	
cæspitosa. Schultz.	D. and W. Common.
palustris. With.	D. and W. Frequent.
repens. Don.	D. and W. Not unfrequent on boggy hills.
arvensis. Hoffm.	D. and W. Common.
collina. Reich.	D. and W. Abundant on the coast, Murrough of Wicklow, at Portmarnock, and at Malahide.
versicolor. Reich.	D. and W. Frequent.
Anchusa.	
‡arvensis. Linn.	D. Frequent, and chiefly on the coast. W. Murrough of Wicklow.
[sempervirens. Linn.]	Near Finglas (Wade, Dublin).
Symphytum.	
officinale. Linn.	D. and W. Frequent. Often occurs with purple flowers.
Cynoglossum.	
officinale. Linn.	D. Frequent near Dublin. On the coast. W. Murrough of Wicklow.
*montanum. Lam.	D. Near Balbriggan; very rare, and probably introduced in this the only Irish locality.

55. Lentibulariaceæ.

Pinguicula.	
vulgaris. Linn.	D. and W. Frequent in the mountain district.
lusitanica. Linn.	D. Foot of the Dublin Mountains. W. Near Roundwood, Annamoe, Lough Dan, etc.

Utricularia.

vulgaris. Linn.	D. and W. Rare. Abundant in ditches on the Murrough of Wicklow.
minor. Linn.	W. On Calary Bog. Sparingly. (W. Archer).

56. Primulaceæ.

Primula.

vulgaris. Huds.	D. and W. Common. The oxlip occurs in Howth.
officinalis. Linn.	D. and W. Common.

Lysimachia.

[vulgaris. Linn.]	D. About Loughlinstown and Old Connaught (Irish Flora.)
[Nummularia. Linn.]	D. At the Old Camp near Loughlinstown (Irish Flora.) Kilmashogue (Wade, Dublin). An escape only.
Nemorum. Linn.	D. and W. Frequent.

Anagallis.

arvensis. Linn.	D. and W. Frequent.
tenella. Linn.	D. and W. Frequent.

Glaux.

maritima. Linn.	D. and W. Common on the sea shore.

Samolus.

Valerandi. Linn.	D. and W. Frequent, especially near the coast.

57. Plumbaginaceæ.

Armeria.

maritima. Willd.	D. and W. Common on the coast.

Statice.

Bahusiensis. Fries.	D. and W. Muddy sea shores, but rather local.
occidentalis. Lloyd.	D. and W. Rocky and gravelly shores. Rather rare.

58. Plantaginaceæ.

Plantago.

major. Linn.	D. and W. Common.
lanceolata. Linn.	D. and W. Common.
maritima. Linn.	D. and W. Common.
Coronopus. Linn.	D. and W. Common.

Littorella.

lacustris. Linn.	D. Howth (Irish Flora.) W. Lough Dan, Luggelaw, Kelly's Lough, etc.

61. Chenopodiaceæ.

Suæda.

maritima. Dum.	D. and W. Muddy sea shore. Frequent.

Salsola.

Kali. Linn.	D. and W. Sandy sea shores. Frequent.

Salicornia.		
herbacea. Linn.	D. and W.	Muddy salt marshes. Common.
b. procumbens. Sm.	D. and W.	Frequent.
Beta.		
maritima. Linn,	D. and W.	Sea shores. Common.
Chenopodium.		
†olidum. Curt.	D.	Formerly in Dublin, but not found for many years.
album. Linn.	D. and W.	Frequent.
b. viride. Linn.	D. and W.	Not uncommon.
†murale. Linn.	D.	Very scarce near Dublin. Howth. Clontarf. Baldoyle. Portobello.
rubrum. Linn.	D.	Rubbish-heaps at mouth of Tolka and Liffey.
‡Bonus-Henricus. Linn.	D. and W.	Frequent.
Atriplex.		
littoralis. Linn.	D.	Sutton. Howth. Portmarnock, etc.
angustifolia. Sm.	D. and W.	Frequent.
b. erecta. Huds.	D. and W.	Frequent.
hastata. Sm.	D. and W.	Frequent.
b. deltoidea. Bab.	D. and W.	Common about Dublin.
Babingtonii. Woods.	D. and W.	Common on the sea-shore.
arenaria. Woods.	D.	Sutton. Baldoyle.
portulacoides. Linn.	D.	Sutton side of Howth. Portrane.

62. Polygonaceæ.

Rumex.		
conglomeratus. Mun.	D. and W.	Common.
nemorosus. Schrad.		
a. viridis. Sibth.	D. and W.	Frequent.
maritimus. Linn.	Dublin or Meath.	Formerly on the bog at Garristown, but now apparently extinct. Not seen in 1877.
[palustris. Sm.]		Once found by the Canal, near Broadstone Station. Accidental.
‡pulcher. Linn.	D.	Bullock Harbour, between Kingstown, and Dalkey. Baldoyle. W. Near the harbour at Bray.
obtusifolius. Linn.	D. and W.	Common.
crispus. Linn.	D. and W.	Common.
Hydrolapathum. Huds.	D.	Malahide, between Raheny and Baldoyle. W. Murrough of Wicklow.
Acetosa. Linn.	D. and W.	Common.
Acetosella. Linn.	D. and W.	Common.
Polygonum.		
Convolvulus. Linn.	D. and W.	Frequent.
aviculare. Linn.	D. and W.	Common.

Polygonum.		
Raii. Bab.	D. and W.	Sandy sea-shores. Not unfrequent.
Hydropiper. Linn.	D. and W.	Common.
minus. Huds.	W.	Near Enniskerry. (J. Ball.) Not gathered recently.
Persicaria. Linn.	D. and W.	Common.
lapathifolium. Linn.	D. and W.	Unfrequent.
amphibium. Linn.	D. and W.	Frequent.
‡Bistorta. Linn.	D.	In a field at Ashtown, near Monkstown. (Mackay Cat. Ir.) Not found recently.

67. Empetraceæ.

Empetrum.		
nigrum. Linn.	D. and W.	Frequent on the Dublin and Wicklow mountains.

68. Euphorbiaceæ.

Euphorbia.		
‡Helioscopia. Linn.	D. and W.	Frequent in cultivated land.
Paralias. Linn.	D. and W.	Frequent on sandy shores.
Portlandica. Linn.	D. and W.	Sandy shores, and rocks. Frequent.
‡Peplus. Linn.	D. and W.	Frequent in cultivated land.
‡exigua. Linn.	D. and W.	Rather rare in cultivated land.
Mercurialis.		
perennis. Linn.	D.	Very rare. Hedge-bank near Finglas.
†annua. Linn.	D.	Abundant near Dublin.

71. Urticaceæ.

Parietaria.		
diffusa. Koch.	D. and W.	Not unfrequent.
Urtica.		
dioica. Linn.	D. and W.	Common.
urens. Linn.	D. and W.	Not unfrequent.
Ulmus.		
*suberosa. Ehrh.	D. and W.	Common, but planted.
b. parvifolia.	D. Santry.	W. Roundwood, &c.
*montana. With.	D. and W.	Frequent, but planted.

72. Amentiferæ.

Quercus.		
Robur. Linn.	D. and W.	Common.
b. sessiliflora. Salisb.	W.	Glens near West Aston.
Alnus.		
glutinosa. Linn.	D. and W.	Common.
Betula.		
alba. Linn.	D. and W.	Frequent.

Myrica.	
Gale. Linn.	D. and W. In mountainous and boggy situations. Local.
Populus.	
tremula. Linn.	D. and W. Rocks and mountains, rather rare.
Salix.	
*fragilis. Linn.	D. and W. Frequent, but planted.
*alba. Linn.	D. and W. Frequent, but planted.
*viminalis. Linn.	D. and W. Frequent, but planted.
†Smithiana. Willd.	D. and W. Not unfrequent.
†acuminata. Sm.	D. and W. In hedges, occasionally.
cinerea. Linn.	D. and W. Common.
b. aquatica. Sm.	D. and W. Not unfrequent.
c. oleifolia. Sm.	D. and W. Not unfrequent.
aurita. Linn.	D. and W. Frequent.
caprea. Linn.	D. and W. Frequent.
repens. Linn.	D. and W. Frequent.
c. prostrata. Sm.	D. and W. Not unfrequent.
f. incubacea. Linn.	D. and W. Not unfrequent.
g. argentea. Sm.	D. and W. Not unfrequent.
herbacea. Linn.	W. Thonelagee and Lugnaquillia.

73. Coniferæ.

Taxus.	
*baccata. Linn.	D. and W. Rare, and escaped from plantations.

74. Typhaceæ.

Typha.	
latifolia. Linn.	D. and W. Frequent, but local.
angustifolia. Linn.	D. Formerly near Sandymount and Merrion. (Extinct through drainage.)
Sparganium.	
ramosum. Huds.	D. and W. Frequent.
simplex. Huds.	D. and W. Not unfrequent.
minimum. Fries.	D. or Meath. Garristown Bay, rare. W. Murrough of Wicklow (D.M.)

75. Araceæ.

Arum.	
maculatum. Linn.	D. and W. Not unfrequent.

76. Lemnaceæ.

Lemna.	
trisulca. Linn.	D. and W. Not unfrequent.
minor. Linn.	D. and W. Common.
gibba. Linn.	D. Pond at Glasnevin.
polyrrhiza. Linn.	D. Near Irishtown and in Phœnix Park.

77. Naiadaceæ.

Potamogeton.	
natans. Linn.	D. and W. Frequent.
polygonifolius. Pom.	D. and W. Boggy places, ponds, lakes, etc.
plantagineus. Ducros.	W. Ditches near Murrough of Wicklow.
rufescens. Schrad	W. Murrough of Wicklow, rare (D.M.)
heterophyllus. Schrad.	D. In the Liffey, &c. W? In the lakes?
lucens. Linn.	D. Phœnix Park. (Wade.) In both Canals near Dublin (D.M.)
perfoliatus. Linn.	D. Liffey above Chapelizod?
crispus. Linn.	D. and W. Frequent.
†densus. Linn.	D. Canal at Portobello, Dublin. Probably conveyed by traffic from the West.
pusillus. Linn.	D. and W. Frequent.
pectinatus. Linn.	D. and W. Local, abundant in the Canals and on Murrough of Wicklow.
Zannichellia.	
palustris. Linn.	D. and W. Frequent.
Ruppia.	
rostellata. Koch.	D. and W. Not unfrequent.
Zostera. Linn.	
marina. Linn.	D. and W. Common.
nana. Roth.	D. Mud-flats, near Baldoyle.

78. Alismaceæ.

Triglochin.	
palustre. Linn.	D. and W. Frequent.
maritimum. Linn.	D. and W. Frequent in muddy salt marshes.
Sagittaria.	
†sagittifolia. Linn.	D. In the Canals near Dublin, and along the Tolka, but probably introduced.
Alisma.	
Plantago. Linn.	D. and W. Frequent.
ranunculoides. Linn.	D. and W. Frequent in boggy places.
Butomus.	
‡umbellatus. Linn.	D. River Tolka, below Glasnevin Bridge, (probably escaped.)

79. Hydrocharidaceæ.

Hydrocharis.	
Morsus-ranæ. Linn.	D. Bogs of Curragha and Garristown and near Balruddery.
Elodea.	
canadensis. Rich.	D. and W. Plentiful in the Canals and streams.

80. Orchidaceæ.

Orchis.
- pyramidalis. Linn. D. and W. Frequent, especially near Dublin.
- Morio. Linn. D. and W. Local and rare. Howth, Kelly's Glen, Baltinglass and near Wooden Bridge, &c.
- mascula. Linn. D. and W. Common.
- latifolia. Linn. D. and W. Frequent.
  - *b.* incarnata. Linn. D. and W. Frequent.
- maculata. Linn. D. and W. Common.

Gymnadenia.
- conopsea. R. Br. D. and W. Frequent.
- albida. Rich. D. Three Rock Mountain, and Kelly's Glen. W. Luggelaw, and other places in Wicklow.

Habenaria.
- viridis. R. Br. D. and W. Rather rare.
- bifolia. R. Br. D. and W. Rather rare.
  - *b.* chlorantha. Bab. D. and W. Frequent.

Ophrys.
- apifera. Huds. D. and W. Rare, and chiefly on coast.
- [muscifera. Linn. Recorded by Wade probably erroneously.]

Spiranthes.
- autumnalis. Rich. D. Rare and local. Killiney. Dalkey. Phœnix Park. Loughlinstown. W. On the commons at Bray.

Listera.
- cordata. R. Br. W. Lough Bray. Glencree. Lough Nahanagan. D. Kelly's Glen.
- ovata. R. Br. D. and W. Not unfrequent.

Neottia.
- Nidus-avis. Rich. D. Luttrellstown-wood, now Woodlands. W. Dargle Woods.

Epipactis.
- latifolia. Linn. D. and W. Rather rare.
- palustris. Linn. D. Portmarnock. Portrane. Howth. Foot Dublin Mountains. W. Murrough of of Wicklow; Enniskerry.

Malaxis.
- paludosa. Sw. D. Kelly's Glen. W. Above the Powerscourt Waterfall. Sugar-loaf Mountain. Roundwood. Ballymurtagh. Tythetewer and Glencree.

81. Iridaceæ.

Iris.
- [*foetidissima. Linn.] D. and W. Occasionally, as an escape from cultivation.

Iris.
Pseudacorus. Linn. D. and W. Common.
Crocus.
[vernus. All.] Near the old castle at Dunganstown (Flor. Hib.)

82. Amaryllidaceæ.

Narcissus.
[Pseudo-narcissus. Linn.] Near Dublin, escape.
[major. Curt.] Near Templeogue, escape.
†biflorus. Curt. D. Howth. Clontarf. Raheny. Finglas. Killiney. Not unfrequent near Dublin.

84. Liliaceæ.

Scilla.
verna. Linn. D. Killiney. Howth. Ireland's Eye. Malahide. W. Murrough of Wicklow and Rockfield.
nutans. Sm. D. and W. Frequent.
Allium.
vineale. Linn. D. Plentiful at Portmarnock and Feltrim Hill, Glasnevin, Phænix Park, etc. W. Rockfield.
ursinum. Linn. D. and W. Not unfrequent.
Narthecium.
Ossifragum. Huds. D. and W. Frequent.
Colchicum.
[autumnale. Linn.] Near Finglas and Scribblestown (Irish Flora.) Probably an error.

86. Juncaceæ.

Luzula.
pilosa. Willd. D. and W. Frequent in Wicklow and Dublin.
sylvatica. Beck. D. and W. Frequent.
campestris. D.C. D. and W. Frequent.
multiflora. Koch. D. and W. Bogs and mountains. Frequent.
Juncus.
acutus. Linn. W. Sand-hills and muddy estuaries between Wicklow and Arklow.
maritimus. Sm. D. and W. Frequent.
conglomeratus. Linn. D. and W. Common.
effusus. Linn. D. and W. Common.
glaucus. Sibth. D. and W. Frequent near the sea.
obtusiflorus. Ehrh. D. Boggy margin of the shore a little east of Dollymount.
acutiflorus. Ehrh. D. and W. Common.
lamprocarpus. Ehrh. D. and W. Frequent.

Juncus.		
supinus. Moench.	D. and W.	Frequent in boggy places.
bufonius. Linn.	D. and W.	Frequent.
Gerardi. Lois.	D. and W.	Frequent on the coast.
squarrosus. Linn.	D. and W.	Frequent on the mountains.

87. Cyperaceæ.

Schœnus.		
nigricans. Linn.	D.	Portmarnock and Portrane sands; near Balbriggan, &c. W. Murrough of Wicklow.
Cladium.		
Mariscus. Brown.	W.	Murrough of Wicklow.
Rhynchospora.		
alba. Vahl.	D. and W.	Local, and rather rare.
Blysmus.		
rufus. Link.	D.	Baldoyle, North Bull. Between Balbriggan and Hampton.
Scirpus.		
palustris. Linn.	D. and W.	Frequent.
uniglumis. Link.	D.	Shore, east of Dollymount.
	W.	Near Killoughter; Wicklow, Arklow, etc., along the coast.
multicaulis. Sm.	W.	Plentiful near Lough Dan, and along Annamoe river (A.G.M.)
pauciflorus. Lightf.	D.	Howth, North Bull; Dollymount; Baldoyle; Portmarnock; Balbriggan.
cæspitosus. Linn.	D. and W.	Common on mountain heaths.
parvulus. R. and S.	W.	On soft mud in the creeks, north side of the mouth of river at Arklow. The only locality in Ireland.
fluitans. Linn.	D. and W.	Not unfrequent.
Savii. S. and M.	D. and W.	Not unfrequent. On coast.
setaceus. Linn.	D. and W.	Rare? and chiefly inland.
lacustris. Linn.	D. and W.	Frequent.
Tabernaemontani. Gm.	D. and W.	Frequent on the coast.
Scirpus.		
maritimus. Linn.	D. and W.	Frequent on the coast.
Eriophorum.		
vaginatum. Linn.	D. and W.	Frequent on moors and bogs.
angustifolium. Roth.	D. and W.	Common.
[latifolium. Hoppe.		Formerly near Enniskerry. Now extinct, as the ground has been drained.
Carex.		
dioica. Linn.	D. and W.	Dublin and Wicklow Mountains. Local.
pulicaris. Linn.	D. and W.	Frequent on dry and boggy heaths.

Carex.	
divisa. Huds.	D. North Lots, near mouth of Liffey. The only locality in Ireland.
disticha. Huds.	D. and W. Not unfrequent.
arenaria. Linn.	D. and W. Frequent.
paniculata. Linn.	D. and W. Local and rather rare.
vulpina. Linn.	D. and W. Not common, and chiefly near coast.
muricata. Linn.	D. Stepaside. Curragha Bog. Howth. W. Fassaroe, near Bray. Delgany.
divulsa. Good.	D. Killiney; near Stillorgan: Feltrim Hill; Castleknock; Celbridge. W. Glen of the Downs, St. Valerie, and Fassaroe.
stellulata. Good.	D. and W. Common.
remota. Linn.	D. and W. Not unfrequent.
? axillaris. Good.	W. ? Luggelaw, Wicklow. (Flor. Hib.)
curta. Good.	D. Curragha Bog. Foot of Three Rock Mountain. W. Near Lough Dan and Roundwood. Shore of Lough Firrib, at 2,100 feet (A.G.M).
ovalis. Good.	D. and W. Frequent.
stricta. Good.	D. By the side of Royal Canal, etc. W. About the lakes in Wicklow.
rigida. Good.	W. Top of Lugnaquillia Mountain, Wicklow, at 3,000 feet.
vulgaris. Fries.	D. and W. Common.
glauca. Scop.	D. and W. Common.
? limosa. Linn.	D. "Curragha Bog." (Wade Rar.) Not found recently.
pilulifera. Linn.	D. and W. Frequent.
præcox. Jacq.	D. and W. Frequent.
pallescens. Lam.	D. Curragha Bog (Wade.) Howth (Ir. Flora.) W. Moist banks near Glendalough.
panicea. Linn.	D. and W. Common.
pendula. Huds.	D. and W. Rare in both counties.
strigosa. Huds.	D. Woodlands, Marino, (Mackay Rar.) and Curragha. (Wade Rar.) W. Dargle and Devil's Glen.
sylvatica. Huds.	D. and W. Frequent.
lævigata. Sm.	D. Kelly's Glen, Dublin. W. Devil's Glen and Enniskerry.
binervis. Sm.	D. and W. Frequent.
distans. Linn.	D. and W. Frequent on the sea shore.
fulva. Good.	D. Howth and Portmarnock. W. Luggelaw, and near Lough Dan.
extensa. Good.	W. Murrough of Wicklow.
flava. Linn.	D. and W. Frequent.
b. lepidocarpa. Tausch.	D and W. Not unfrequent.
c. Œderi. Ehrh.	? Frequent.

Carex.		
hirta. Linn.	D.	and W. Not unfrequent.
Pseudo-cyperus. Linn.	D.	Brackenstown, and near Curragha. (Wade.) W. Dargle, (Wade), and near Newcastle, Wicklow. (A.G.M).
paludosa. Good.	D.	Grand Canal, near Dublin. Plentiful.
	W.	Murrough of Wicklow. Newcastle.
riparia. Curtis.	D.	Donabate.
	W.	Murrough of Wicklow.
ampullacea. Good.	D.	and W. Local.
[? vesicaria. Linn.]		Curragha Bog. (Wade.) Probably C. ampullacea was mistaken for it.

88. Gramineæ.

Anthoxanthum.		
odoratum. Linn.	D.	and W. Common.
Digraphis.		
arundinacea. Trin.	D.	and W. Frequent.
Phalaris.		
[canariensis. Linn.]		Occasional. Not indigenous.
Alopecurus.		
geniculatus. Linn.	D.	and W. Frequent.
pratensis.	D.	and W. Not unfrequent.
Phleum.		
pratense. Linn.	D.	and W. Not common.
arenarium. Linn.	D.	Sandymount. Howth. Baldoyle. Portmarnock.
	W.	Arklow. Murrough of Wicklow.
Agrostis.		
canina. Linn.	D.	and W. Frequent on heaths and bogs.
alba. Linn.	D.	and W. Common.
vulgaris. With.	D.	and W. Common.
b. pumila. Lightf.	D.	and W. Not unfrequent.
Psamma.		
arenaria. R. et S.	D.	and W. Frequent on sandy sea-shores.
Phragmites.		
communis. Trin.	D.	and W. Common.
Milium.		
effusum. Linn.	W.	Newtown-Mount-Kennedy. Tinnehinch, Dargle, and Powerscourt.
Aira.		
cæspitosa. Linn.	D.	and W. Very frequent.
flexuosa. Linn.	D.	and W. Frequent, but local.
caryophyllea. Linn.	D.	and W. Frequent.
præcox. Linn.	D.	and W. Frequent.
Avena.		
flavescens. Linn.	D.	and W. Not common, and local.

Avena.	
pubescens. Linn.	D. and W. Not unfrequent.
[strigosa. Schreb.]	Cultivated land. Rare.
‡fatua. Linn.	Portmarnock.
elatior. Linn.	D. and W. Common.
Holcus.	
mollis. Linn.	D. and W. Not common.
lanatus. Linn.	D. and W. Common.
Triodia.	
decumbens. Beauv.	D. and W. Frequent.
Kœleria.	
cristata. Pers.	D. and W. Not unfrequent.
Molinia.	
cærulea. Mœnch.	D. and W. Frequent.
Melica.	
uniflora. Retz.	D. and W. Not unfrequent.
Catabrosa.	
aquatica. Beauv.	D. and W. Not unfrequent.
Glyceria.	
fluitans. Brown.	D. and W. Common.
b. plicata. Fries.	D. and W. Near Glasnevin and Dublin, etc.
aquatica. Sm.	D. Plentiful in the canals near Dublin, and along the Liffey. W. Murrough of Wicklow.
Sclerochloa.	
maritima. Lindl.	D. and W. Frequent.
distans. Bab.	D. Howth. Clontarf. North-wall. Ringsend. Kingstown, etc.
Borreri. Bab.	D. Plentiful in the North Lots, near mouth of Liffey. The only Irish locality.
rigida. Link.	D. Common near Dublin and Wicklow.
loliacea. Woods.	D. and W. Frequent on the coast.
Poa.	
annua. Linn.	D. and W. Common.
nemoralis. Linn.	D. Plentiful at Woodlands, near Dublin. W. At the Dargle.
[compressa. Linn.]	Foot of Dublin mountains? (White MS.) Probably a mistake.
pratensis. Linn.	D. and W. Common.
trivialis. Linn.	D. and W. Common.
Briza.	
media. Linn.	D. and W. Frequent.
Cynosurus.	
cristatus. Linn.	D. and W. Common.
Dactylis.	
glomerata. Linn.	D. and W. Common.

Festuca.		
uniglumis. Soland.	D.	Portmarnock. Ireland's Eye. Portrane. W. Wicklow and Arklow.
Pseudo-myurus. Soyer.	D.	Howth and Donnybrook. W. Arklow and Wicklow.
sciuroides. Roth.	D.	and W. Not unfrequent.
ovina. Linn.	D.	and W. Common.
rubra. Linn.	D.	and W. Frequent.
a. duriuscula. Linn.	D.	and W. Frequent.
b. arenaria. Osb.	D.	and W. Frequent on sand-hills.
sylvatica. Vill.	W.	Dargle. Powerscourt. Devil's Glen.
elatior. Linn.	D.	and W. Rather local.
b. arundinacea. Schreb.		Rather local. On sea-shore.
pratensis. Huds.	D.	and W. Frequent.
b. loliacea. Huds.	D.	and W. Occasional.
Bromus.		
giganteus. Linn.	D.	and W. Frequent.
asper. Linn.	D.	and W. Frequent.
erectus. Huds.	D.	Portmarnock, Glasnevin, Finglas, Santry, sides of Royal Canal, &c. W. Bray Head.
sterilis. Linn.	D.	Common near Dublin.
[secalinus. Linn.]		Cornfields, rare.
racemosus. Linn.	D.	and W. Not unfrequent.
commutatus. Schrad.	D.	Between Raheny and Howth? Sandymount.
mollis. Linn.	D.	and W. Common.
Brachypodium.		
sylvaticum. R. et S.	D.	and W. Frequent.
Triticum.		
caninum. Huds.	D.	Woodlands and other places near Dublin. W. Powerscourt.
repens. Linn.	D.	and W. Common.
b. pungens. Pers.	D.	and W. Sea-shore, frequent.
acutum. D. C.	D.	and W. Frequent on sea sands.
junceum. Linn.	D.	and W. Frequent on sea sands.
Lolium.		
perenne. Linn.	D.	and W. Frequent.
[italicum. Brown.]		An escape from cultivation.
‡temulentum. Linn.	D.	and W. Locally abundant.
b. arvense.	D.	and W. Not unfrequent.
Lepturus.		
incurvatus. Trin.	D.	and W. Frequent.
Hordeum.		
‡sylvaticum. Huds.	D.	In a shrubbery at Mount Merrion, near Dublin. The only locality in Ireland.
pratense. Huds.	D.	Fields at Glasnevin and Portmarnock. Meadows near Dublin. W. Murrough of Wicklow.

Hordeum.
†murinum. Linn. — D. Common about Dublin. W. Near Wicklow.

Nardus.
stricta. Linn. — D. and W. Frequent on mountain heaths.

89. FILICES.

Hymenophyllum.
Wilsoni. Hook. — D. Kelly's Glen. W. Frequent in the Glens and mountains.

[Trichomanes.]
[radicans. Sw.] — W.? Found many years ago at Powerscourt Waterfall, and in Hermitage Glen, Wicklow (*fide* Flora Hibernica).

Pteris.
aquilina. Linn. — D. and W. Common.

Blechnum.
boreale. Sw. — D. and W. Frequent in mountainous districts.

Asplenium.
Ruta-muraria. Linn. — D. and W. Frequent.
Trichomanes. Linn. — D. and W. Frequent.
marinum. Linn. — D. and W. Frequent on rocky shores.
Adiantum-nigrum. L. — D. and W. Frequent.
[*b*. acutum. Bory.] — Dunran Wood, near Newtown-mount-Kennedy, Wicklow, (D. Orr.)

Athyrium.
Filix-fœmina. Bernh. — D. and W. Common.

Ceterach.
officinarum. Willd. — D. and W. Rare and local.

Scolopendrium.
vulgare. Sm. — Frequent.

Cystopteris.
fragilis. Bernh. — W. Maulin mountain, Glen Cree.

Polystichum.
aculeatum. Roth. — D. and W. Very local, and rare.
angulare. Newm. — D. and W. Abundant.

Lastrea.
Filix-mas. Presl. — D. and W. Common.
b. Borreri. Newm. — D. and W. Frequent.
spinulosa. Presl. — W. Near the Powerscourt Waterfall.
dilatata. Presl. — D. and W. Common.
æmula. Brack. — D. Cotbrook Glen, and Glen in Featherbed mountain, and north side of Howth. W. Plentiful at Glendalough, &c.
Thelypteris. Presl. — D. Kelly's Glen. W. Glencree (Mackay).
Oreopteris. Presl. — D. Rare. Kelly's Glen, and near Step aside, at base of Dublin Mountains. W. Glendalough, Sugarloaf Mountain, &c. Not unfrequent.

Polypodium.	
vulgare. Linn.	D. and W. Frequent.
b. cambricum.	W. In the Dargle.
Phegopteris. Linn.	W. Powerscourt Waterfall and Maulin Mountain, Glen Cree.
Osmunda.	
regalis. Linn.	D. Kelly's Glen (Mackay). Probably extinct. W. Side of river below Glendalough, Devil's Glen, &c.
Ophioglossum.	
vulgatum. Linn.	D. and W. Rare.
Botrychium.	
Lunaria. Sw.	D. and W. Rather rare. Kelly's Glen, &c.

90. Lycopodiaceæ.

Lycopodium.	
clavatum. Linn.	D. and W. Local in the Dublin and Wicklow Mountains.
alpinum. Linn.	D. On Feather-bed Mountain, above Killakee (D. Orr).
Selago. Linn.	D. and W. Frequent on the mountains.
Selaginella.	
spinosa. A. Br.	D. Sandhills at Portmarnock and Portrane; Howth. W. Glencree, Glencullen, &c.
Isoetes.	
lacustris. Linn.	W. Upper Lough Bray and Lough Dan. The plant here grows to an extraordinary length, often 24 to 27 inches.
b. echinospora. Dur.	W. Upper Lough Bray (Milde).

92. Equisetaceæ.

Equisetum.	
arvense. Linn.	D. and W. Frequent.
maximum. Lam.	D. Very rare. Near Howth, Kelly's Glen, and Dodder Valley. W. Near the Dargle, and in Powerscourt, &c.
sylvaticum. Linn.	D. Kelly's Glen, Ballinascorney, and Portmarnock. W. Roundwood, &c.
palustre. Linn.	D. and W. Common.
limosum. Linn.	D. and W. Common.
hyemale. Linn.	D. Near Whitechurch, Finglas (Rutty), Lucan, Woodlands, Leixlip. W. Powerscourt and Kilcroney.
b. Moorei. Newman.	W. Sandhills on the coast, between Arklow and Wicklow.
variegatum. Schl.	D. Portmarnock and Portrane.
b. Wilsoni. Newm.	Banks of Royal Canal, east of Clonsilla station; and sparingly near the Cross Guns, Glasnevin.

LIST OF THE MOSSES OF THE COUNTIES OF DUBLIN AND WICKLOW, WITH THEIR PRINCIPAL LOCALITIES,

BY

DAVID MOORE, PH.D., F.L.S.

[Read March 18, 1878.]

For full list of Irish Mosses, see "Synopsis of all the Mosses known to inhabit Ireland." Proceedings of Royal Irish Academy, Vol. 1, Series 2. Science by D. Moore, Ph.D.

TRIBE 1.—TETRAPHIDEÆ.

Tetraphis. Hedw.

pellucida, Hedw. Species Musc., tab. 7, f. 1. Eng. Bot., tab. 1020. Bryol. Brit., p. 86, tab. 8. W. On dry banks at Lough Bray. Rare.

Tetrodontium. Schwæger.

Brownianum, Dicks. Bryol. Brit., p. 195, tab. 8. Tetraphis Browniana, Muscol. Brit., Ed. 2, p. 33, tab. 1. Grimmia Browniana, Eng. Bot. tab. 1422. W. Dry shaded rocks, at Lough Bray. D. In similar places at the head of Kelly's Glen. Rare.

TRIBE 2.—DICRANEÆ.

Pleuridium. Schimp.

subulatum, Schimp. Bryol. Europ., vol. 1, tab. 9. Coroll., p. 6. Phascum subulatum, Linn., Engl. Bot., tab. 2177. Muscol. Brit., Ed. 2, p. 6, tab. 5. Clay banks, and pasture fields. D. In similar places.

Brachyodus. Nees et Hornsch.

trichodes, Nees et Hornsch. Bryol. Germ., tab. 25. Weissia trichodes, Musc. Brit., Ed. 2, p. 83, tab. 15. Grimmia trichodes, Engl. Bot., tab. 2563. W. On rocks of granite and sandstone, near Lough Bray. D. On the same formation, in Kelly's Glen. Rare.

Dicranella. Schimp.

squarrosa, Schimp. Synops. Musc., p. 71. Briol. Ital., p. 642. Dicranum squarrosum, Schrad, Journ.-Muscol. Brit., Ed. 2, p. 98. W. On wet banks, near Seven Churches. D. By the margins of streams, in Kelly's Glen.

Schreberi, Hedw. Dicranum Schreberi. Bryol. Europ., vol. 1, Monog., p. 18, tab. 53. D. On moist, clayey banks, near Dunsink. Not hitherto observed elsewhere in Ireland.

Grevilleana, Schimp. Dicranum Grevilleanum, Bryol. Brit., p. 69, t. 33. D. Schreberianum, Muscol. Brit., ed. 2, p. 95. W. Wet gravelly banks on the side of Lugnaquilla mountain. Barren.

cerviculata, Schimp. Synops. Musc., p. 72. Dicranum cerviculatum Hedw., Bryol. Brit., p. 72, t. 16. W. On moist banks, where the soil is of a peaty nature, frequent. D. In similar places, frequent.

heteromalla, Schimp. Synops. Musc., p. 75. Dicranum heteromallum Hedw. Turner, Muscol. Hib., p. 161. Bryol. Brit., p. 73, t. 18. W. Damp ditch banks. C. D. Common.

varius, Schimp. Synop. Muscor., p. 72. Dicranum varium, Hedw. W. On moist sandy banks, and by road-sides. C. D. C.

rufescens, Schimp. Synops. Musc., p. 74. Dicranum rufescens, Turn. Musc. Hib., p. 66. W. Damp places, Lough Bray. D. In Kelly's Glen.

Ceratodon. Bridel.

purpureus, Bridel. Bryol. Univ., l, p. 480. Didymodon purpureum Muscol. Brit., ed. 2, p. 113. W. On dry banks, sand hills near the sea coast, and on heaths which have been burned. C. D. In similar places. Common.

Rhabdoweissia. Br. et Schimp.

fugax, Br. et Schimp. Bryol. Europ., vol. 1, t. 41. Weissia striata var. minor. Hook and Tayl., Muscol. Brit., ed. 2, p. 81. W. Crevices of rocks, &c., Glenmalur and Powerscourt Waterfall.

denticulata, Br. et Schimp. Weissia denticulata, Bryol. Univer., 1, p. 342. W. Crevices of rocks, Glenmalur and Upper Lough Bray.

Blindia. Br. et Schimp.

acuta Br. et Sch. Bryol. Europ., vol. 2. Monog., p. 3, t. 114. Weissia acuta, Hedw. W. Dripping rocks, and moist banks in sub-alpine places, Lough Bray. D. Kelly's Glen.

Cynodontium. Br. et Schimp.

Bruntoni Br. et Schimp. Bryol. Europ., vol. 1, t. 44. Dicranum Bruntoni, Eng. Bot., t. 2509. Didymodon Bruntoni, Muscol. Brit., ed. 2, p. 117. W. Damp rocks, at the Waterfall, Powerscourt, and near Seven Churches. Rare.

Dicranum. Hedw.

Scottianum, Turner. Muscol. Hib., p. 75. Eng. Bot., t. 1977. Bryol. Brit., p. 75, t. 18. W. Damp rocks, at Lough Bray and Glenmalur. Rare.

fuscescens, Turner. Muscol. Hib., p. 60. Bryol. Brit., p. 77, t. 18. Dicranum Scoparium, var. β. fuscescens. Muscol. Brit., ed. 2, p. 101. Hab. W. Damp rocks, Luggelaw and Upper Lough Bray. Rare.

scoparium, Hedw. Sp. Musc., t. 126. W. On rocks and trees, with its varieties. C. D. In similar places. Common.

majus, Turner. Muscol. Hib., p. 58. Dicranum scoparium var. majus. Muscol. Brit., ed. 2, p. 101. W. Trunks of trees in shady situations, and on banks and rocks at Lough Bray, and Powerscourt Waterfall.

Campylopus. Bridel.

longipilus, Bridel. Bryol. Univ., 1, p. 477. Bryol. Brit., p. 90, t. 40. Dicranum longipilum, C. Muller, Synop. Muscor., 1, p. 414. W. Turf bogs and wet rocks, at Seven Churches. Barren.

brevipilus, Br. et Schimp. Bryol. Europ., vol. 1, t. 92. Bryol. Brit., p. 8!, t. 40. Dicranum brivipilum. C. Muller, Synops. Muscor., vol. 1, p. 412. D. Bogs and wet banks, on the Hill of Howth. Barren.

alpinus, Schimp. Muscor. Europ. Nov., fasc. 1 et 2. C. intermedius, Wils. M. S. fide Braithwaite, in "Journal of Botany," p. 4, Dec. 1870. W. On moist rocks and banks, Lough Bray and Powerscourt Waterfall. D. Kelly's Glen.

flexuosus, Dill. Bryol. Europ., vol. 1, Monogr., p. 3, t. 89. Bryol. Brit., p. 90, t. 16. Dicranum flexuosum, Muscol. Brit., ed. 2, p. 94. W. Damp rocks and moist banks, at Lough Bray. D. In similar places, Kelly's Glen.

setifolius, Wils. Bryol. Brit., p. 89, t. 40. Schimp. Musc. Europ., No. 1055. W. On wet banks among grass and heath, near the Waterfall at Powerscourt.

fragilis, Br. et Schimp. Bryol. Europ. vol. 1, Monogr., p. 4, t. 90. C. densus, Bryol. Brit., p. 88, t. 40. Dicranum flexuosum var. fragile, Turner, Muscol. Hib., p. 74. W. Bogs, rocks, and shady banks at Lough Bray and Powerscourt. D. Hill of Howth.

torfaceus, Br. et Schimp. Bryol. Europ., vol. 1, Monogr., p. 5, t. 91. Dicranum flexuosum Hedwig, Sp. Musc., t. 28. Bryum fragile, Dicks, fasc. 3, p. 5. W. Shady banks, margins of cut, drains, &c. C. D. In similar situations. Common.

Dicranodontium. Bruch et Schimp.

longirostre, Br. et Schimp. Bryol. Europ., vol. 1, tab. 88. Bryol. Brit., p. 86, t. 39. Didymodon longirostrum, Web. et Mohr. W. Shady banks and crevices of rocks, at Lough Bray and Glenmalur.

TRIBE 3.—GRIMMIEÆ.

Campylostelium Bruch et Schimp.

saxicola, Br. et Schimp. Broyl. Brit., p. 52, t. 13. Dryoptodon saxicola, Bridel. Bryol. Univ., 1, p. 770. Grimmia saxicola Musc. Brit., ed. 2, p. 67. W. On granite rocks near Lough Bray. D. On similar formation, about Kelly's Glen.

Grimmia Ehrh.

pulvinata, Smith. Engl. Bot., t. 1728; Muscol. Brit., ed. 2, p. 68. W. On walls and rocks. C. D. Common.

orbicularis, Br. et Sch. Bryol. Europ., vol. 3. Monogr., p. 13, t. 240. Broyl. Brit., p. 154, t. 45. D. On the faces of walls in warm situations; wall by the roadside leading to Dublin from Stillorgan.

spiralis, Hook and Taylor. Muscol. Brit., p. 69. Dryoptodon spiralis, Bridel. Broyl. Univ. 1, p. 772. W. On rocks at Upper Lough Bray. (Barren.)

torquata, Greville. Scot. Crypt. Fl., [t. 199. G. torta, Nees et Hornsch. Bryol. Brit., p. 156, t. 32. W. On moist rocks near the summit of Sugarloaf Mountain.

trichophylla, Greville. Scot. Crypt. Fl. t. 100. Dicranum pulvinatum, var. argenteum, Turn. Musc. Hib., p. 78. W. On rocks where the river is crossed going from Luggelaw to Lough Dan. D. On the mountains. Frequent.

Schultzii, Bridel. Bryol. Univ., 1, p. 199. Bryol. Brit., p. 157, t. 45. Trichostomum patens, Var. piliferum. Muscol. Brit., p. 105. D. Rocks at Luggelaw. D. Near the Scalp.

patens, Br. et Sch. Bryol. Europ., vol. 3. Monogr., p. 18, t. 246. Trichostomum patens, Schwægr. Suppl., t. 37. W. Moist rocks at the Waterfall, Powerscourt.

ovata, Web. et Mohr. Bryol. Brit., p. 160, t. 13. Muscol. Brit., ed. 2, p. 71. D. On rocks, Hill of Howth, and Killiney Hill. (Barren.)

Schistidium, Br. et Schimp.

maritimum, Br. et Sch. Bryol. Europ. Monogr., p. 10, t. 255. Bryol. Brit., p. 151, t. 13. Grimmia maritima Turn. Musc. Hib., t. 3, p. 2. On rocks close to the sea, D. W. Common.

Ptychomitrium, Br. et Schimp.

polyphyllum, Br. et Schimp. Bryol. Europ., vol. 3. Monogr. p. 4, t. 229. Bryol. Brit., p. 173, t. 19. Trichostomum polyphyllum, Turn Musc. Hib., p. 35, t. 7. W. On rocks at Lough Bray. D. Near the Scalp, and at Killake.

Racomitrium, Bruch et Schimp.

canescens, Bridel. Bryol. Univ., 208. Bryol. Brit., p. 170, t. 19. Trichostomum canescens Hedw., St. Cr., 3, t. 3. Eng. Bot. t. 2534. W. Damp sandy ground, and among rocks frequent. D. In similar places frequent.

lanuginosum, Bridel. Bryol. Univ., 1, p. 215. Bryol. Brit., p. 169. t. 19. Trichostomum lanuginosum Hedw. Turner Muscol. Hib., p. 38. W. On heaths and on the roofs of thatched houses in continuous layers. D. In similar situations. Common. In both places.

heterostichum, Bridel. Bryol. Univ., 1, p. 214. Bryol. Brit., p. 163, t. 19. Trichostomum heterostichum Hedw., Smith, Eng. Bot., t. 1347. W. Among rocks and on walls, Lough Bray and Seven Churches. D. In similar places. Frequent. The varieties β. alopecurum, γ. gracilescens, δ. pumilum occasionally occur in both counties.

sudeticum, Br. et Schimp. Bryol. Europ., vol 3. Monogr., p. 7, t. 264. Trichostomum microcarpon, Hedw. Turner, Muscol. Hib. p. 40. W. On rocks at Lough Bray.

aciculare, Bridel. Bryol. Univ., 219. Bryol. Brit., p. 165, t. 19. Trichostomum aciculare, Muscol. Brit., p. 107. W. On rocks, in the beds of the mountain streams, Lough Bray, and Powerscourt. D. In similar places about Killakee. Frequent in both counties.

protensum, Al. Braun. Bryol. Europ., vol. 3, Monogr. p. 6. t. 263. R. aquaticum, Bridel. Bryol. Univ., 1, p. 222. Dicranum aciculare, γ. gracile. Turn. Musc. Hib., p. 67. W. Rocks in the mountain torrents, at Upper Lough Bray.

ellipticum, Br. et Sch. Bryol. Europ., vol. 3, Monogr. p. 5, t. 261. Dicranum ellipticum, Turn, Muscol. Hib., p. 76. Trichostomum ellipticum, Muscol. Brit., ed. 2., p. 109. W. Moist rocks near the summit of Lugnaquilla.

fasciculare, Bridel. Bryol. Univ., 1, p. 218. Trichostomum fasiculare, Turn., Musc. Hib. p. 39. W. On rocks and stones among the mountains. C. D. In similar places. Common in both counties.

TRIBE 4.—LEUCOBRYEÆ.

Leucobryum. Hampe.

glaucum, Hampe. Rabenhor. Bryothee. Europ., No. 30. Bryol. Brit., p. 82, t. 16. Dicranum glaucum, Hedw. Turner, Musc. Hib., p. 73. Eng. Bot. t. 2166. Oncophorus glaucus. Bryol. Europ., vol. 1, Monogr., p. 5, t. 97 et 98. W. On heaths and bogs on the mountains, frequent. D. In similar places, on the Hill of Howth, and the mountains about Killakee, frequent, but barren.

TRIBE 5.—TRICHOSTOMACEÆ.

Phascum.

cuspidatum, Schreber. De phasc, p. 8, t. 1, f. 2. Bryol. Brit., p. 31, t. 5. P. acaulon, Linn. Sp. Plant, 1570. D. Banks and fields, frequent. The variety δ. piliferum. Bryol. Brit., occurs on hedge banks near Baldoyle and at Howth.

p. bryoides, Dicks. Crypt. Fasc. 4, t. 10, f. 3. Eng. Bot. t. 1180. Bryol. Brit., p. 33, t. 5. D. On banks and in fields. Hill of Howth, very rare. The only locality in Ireland at present known.

rectum, Wither. Bot. Arr., ed. 4, p. 771. t. 18, f. 1. Bryella recta, Berk. Handb. Brit. Mosses, p. 300. D. Frequent, but rarer elsewhere through the country.

curvicollum, Hedw. Sp. Muscor., p. 21, Eng. Bot., t. 905. D. "On Banks near Dublin; more rare than the last." (fide Taylor*).

* In Fl. Hib. I hav never collected this plant in Ireland, nor have I seen Irish specimens of it.—D.M.

Gymnostomum. Hedwig.

rupestre, Schwaegr. Suppl., vol. 1, p. 11, t. 33-34. Muscol. Brit. p. 19. Bryol. Brit., p. 42, t. 32. W. Fissures of wet rocks in sub-alpine rivulets, Dargle river. D. Killakee Glen, sparingly.

microstomum, Hedw. Stirp. Crypt., 3, p. 71, t. 30. Eng. Bot., t. 2215. Hymenostomum, Bryol. Europ. vol. 1. Monogr. p. 4, t. 16. W. Banks and fields. C. D. In similar places Common.

Pottia. Ehrh.

cavifolia, Ehrh. Beitrage. Bryol. Europ., vol. 2. Monogr. p. 7, t. 118. Gymnostomum ovatum, Hedw. Eng. Bot. 1889. Barbula cavifolia, Schimp. Synop. Muscor., p. 734. D. On the tops of mud walls by waysides. C. But only so in that county.

Wilsoni, Br. et Schimp. Bryol. Europ., vol. 2, Monogr., p. 11, t. 122. Gymnostomum, Wilsoni, Hook. in Bot. Miscel, 1830, vol. 1, p. 43, t. 41. Suppl. Eng. Bot., t. 2710. D. Banks and tops of walls built of mud, especially near the sea, at Howth and Killiney. W. At Bray Head.

Starkeana, C. Muller. Synops. Musc. Mitten, in "Journal of Botany," vol. 9, No. 97. Weissia Starkeana, Muscol. Brit., p. 79, t. 14. Grimmia Starkeana, Turner, Musc. Hib., p. 26. Gymnostomum conicum, Schwaegr., Suppl., t. 9. D. Banks and fields at Howth, Killiney, and near Clontarf.

The Variety β. brachyodus, Weissia affinis, Hook and Tayl. Grows on the Railway banks near the Killiney Station.

Heimii, Br. et Schimp. Bryol. Europ., vol. 2, Monogr., p. 12, t. 124. Bryol. Brit., p. 96, t. 7. Gymnostomum Heimii, Hedw. Turn. Musc. Hib., p. 9. Muscol. Brit., p. 22. D. Banks and marshy places near the sea, near the North Wall, and Portmarnock.

lanceolata, Müller. Synops. Muscor., Mitten in "Seeman's Journal of Botany," vol. 9, p. 3. Anacalypta lanceolata, Rohling, Moosgeschichte Deutchl. Gymnostomum intermedium, Turner, Musc. Hib., p. 7, t. 1, fig. a. c. D. Fields, banks, and waste ground where the soil is of a calcareous nature frequent.

truncata, Br. et Schimp. Bryol. Europ., vol. 2, Monogr., p. 9, t. 120-121. Bryol. Brit., p. 94, t. 7. Gymnostomum truncatum, Nees et Hornsch. Bryol. Germ., t. 9, fig. 8. W. Fallow fields, banks and moist ground. C. D. In similar places. Common.

crinita, Wilson. Bryol. Europ., vol. 2, Suppl. 1, t. 123. Bryol. Brit., p. 95, t. 41. D. Banks facing the sea, Hill of Howth, rare.

Anœctangium. Br. et. Schimp.

compactum, Schwægr. Suppl., t. 2. Bryol. Brit., p. 311, t. 6. Gymnostomum æstivum, Hedw. Sp. Musc., t. 2, fig. 4. G. luteolum, Engl. Bot., t. 220. Hedwigia æstiva, Muscol. Brit., p. 18. W. In crevices of wet rocks. Upper Lough Bray, rare.

Weissia, Hedw.

viridula, Bridel. Bryol. Europ., Vol. 1., Monogr., p. 5, t. 21. W. controversa, Hedw. Hook and Tayl. Muscol. Brit., p. 85. Bryol. Brit., p. 46, t. 15. W. Dry banks and waste places. C. D. In similar places. Common.

cirrhata, Hedw. Sp. Musc., t. 12. Bryol. Brit., p. 47, t. 15. W. On rocks on Sugar-loaf Mountain, and Lough Bray. D. Hill of Howth, and at Killiney.

verticillata, Bridel. Spec. Musc., p. 121. Bryol. Brit., p. 49, t. 15. Grimmia verticillata, Turner, Musc. Hib., p. 31. Eucladium verticillatum, Bryol. Europ., vol. 1, Monogr., p. 3, t. 40. W. On calcareous wet rocks, Lough Bray. D. On similar formation, near the sea, at Howth.

Splachnobryum, C. Muller.

Wrightii, C. Mull. Braithwaite, in "Journal of Botany" for July 1872, plate 123. Entosthodon minimus, Hunt in "Manchester Lit. and Phil. Society's Memoirs," 11, p. 19, 1871. Amblyphyllum hibernicum, Lindb. MS. On the walls and floors of a forcing plant pit, Botanic Garden, Glasnevin. This little moss has for several years been noticed growing annually within this limited locality. It is, no doubt, an alien which has been introduced with foreign plants from the West Indies, and become naturalised here, where it grows.

Didymodon. Br. et Schimp.

cylindricus, Br. et Schimp. Bryol. Europ., vol. 2, Monogr. p. 5, t. 187. Trichostomum tenuirostre, Lindberg, Trichost, Europ. p. 15. Weissia tenuirostris, Muscol. Brit., p. 83, t. 3. W. On wet banks and rocks in the mountain streams Lough Bray and Powerscourt Waterfall. D. In similar places, frequent among the mountains.

rubellus, Br. et Schimp. Bryol. Europ. vol. 2. Monogr. p. 3, tab. 185. Weissia curvirostra. Hook and Tayl., Muscol. Brit. p. 84. W. Wet banks and damp walls, frequent. D. In similar situations, frequent.

Trichostomum. Br. et Schimp.

flavovirens, Bruch. In Mull. Musc. Sardin. Bryol. Europ., vol. 2. Monogr., p. 6, t. 172. W. Sandhills near the sea. C. D. In similar places. Common.

crispulum, Bruch et Schimp. Bryol. Europ., vol. 2. Monogr. p. 7, t. 173. Byrol. Brit, p. 111, t. 41. Diodymodon crispulus. Tayl. in Fl. Hib., p. 18. W. Rocks and banks, chiefly on limestone formation, frequent. D. On similar formation. Common.

tophaceum, Br. et Schimp. Bryol. Europ., vol. 2. Monogr. p. 9, t. 175. Bryol. Brit., p. 113, tab. 20. Didymodon trifarium. Hook and Tayl. Muscol. Brit. ed. 2, p. 118, 20. W. On wet clay banks and on rocks, frequent. D. Frequent.

Ditrichum. Timm.

flexicaule, Hampe. l. c. Leptotrichum flexicaule, Muller. Synop. Muscor., 1, p. 449. Trichostomum flexicaule, Bryol. Europ. vol. 2. Monogr. p. 15, tab. 180. Bryol. Brit. p. 116, tab. 42. Hab. W. On sand hills near the sea, and on dry rocky places inland. Murrough of Wicklow and Arklow, and generally distributed through the county. D. In similar places, Portmarnock and Malahide sands, and at the North Bull, frequent.

Tortula, et Barbula, Hedw.

lamellata, Lindberg, Om. de. Europeiska Trichostomeæ, p. 23. Helsingfors, 1864. Gymnostomum ovatum, var. δ gracilis Wils. Bryol. Brit., p. 93. G. ovatum, var. β gracilis. Hook and Tayl. Musc. Brit., ed. 2, p. 2. D. On the tops of mud walls. C.

rigida, Schultz. Recens. Gen. Barbula. et Syntrichia, t. 32, f. 1. Barbula rigida, Bryol. Europ., vol. 2. Monogr., p. 13. t. 137. D. On the tops of walls, frequent.

ambigua, Wils. Bryol. Brit., p. 120, t. 42. T. rigida. Turner. Musc. Hib. Spicil., p. 43. D. On the tops of walls. Common.

aloides, Koch. De Notr. Musc. Ital., 1, p. 15, tab. 1. Barbula aloides, Byrol. Europ., vol. 2, Monogr. p. 15. t. 139. Hab. W. On clay banks. C. D. Common.

atrovirens, Taylor. In "London Journal of Botany." Jan. 1846 Grimmia atrovirens. Smith, Engl. Bot. tab. 2015. Hab. W. On banks near the sea. C. D. Common.

revoluta, Schwaegr. Suppl. 1. 127, tab. 32. Barbula revoluta Bryol. Europ., vol. 2. Monogr. p. 27, t. 153. W. On walls. W. D. Common.

convoluta, Hedw. Stirp 1, p. 86. Bryol. Brit., p. 127, t. 12. Barbula convoluta, Rabenhor. Bryothec. Europ., No. 229, W. On walls, and on hard ground. C. D. C. The variety β.. Sardoa. Wils., was found near Luttrelstown, Dublin, by Dr. Taylor.

cuneifolia, Dickson. Bryum cuneifolium Dicks., Peant. Crypt. Brit., fasc. 3, p. 7. Bryol. Brit., p. 128, t. 12. D. On banks near the sea. North side of the Hill of Howth. Rare.

Vahliana, Schultz. Recens. 222, t. 34, f. 34. T. oblongifolia, Bryol. Brit., p. 129, t. 43. Var. β. subflaccida, Lindberg. D. On mud banks frequent. The variety β. subflaccida is also frequent.

muralis, Timm. Fl. Megapol., p. 220. Bryol. Brit., p. 130. W. Walls and banks. C. D. Common.

unguiculata, Hedw. De Notr., Syllab., No. 932. Bryol. Brit., p. 24, t. 12. W. On walls, rocks, and banks. C. D. Common.

fallax, Hedw. De Notr. Musc. Ital., 1, p. 58, t. 29. Bryum imberbe Huds., Fl. Angl., Ed. 1, p. 409. W. Banks and damp walls. C. D. Common.

vinealis, Bridel. Bryol. Brit., p. 124, t. 10. W. On walls and rocks. C. D. Common.

rigidula, Mitten. In "Seeman's Journal of Botany," vol. 5, 1867. Trichostomum rigidulum, Turn., Musc. Hib., p. 34. Bryol. Brit., p. 114. W. On wet clay banks frequent. D. In similar places frequent.

insulana, De Notr. In Mem. Acad., Turin, p. 40, 320, id. Syllab., p. 180. T. vinealis, β. flaccida, Bryol. Brit., p. 124. Zygotrichia cylindrica Tayl. in Fl. Hib., p. 26. W. By the side of the Dargle River.

subulata, Bridel. Spec. Musc., vol, 1, p. 267. Bryum subulatum Lin. Spec. Plant. T. subulata, Hedwig. Eng. Bot., tab. 1101. Bryol. Brit., p. 132, t. 12. W. and D. Hedge-banks, on the trunks of trees, and on walls, frequent.

latifolia, Bruch. Bryol. Brit., p. 133, t. 43. Syntrichia latifolia, Bruch. M.S. Hubener, Muscol. Germ., p. 342. D. On old wood, and on the stems of Alder and Willows which are frequently submerged, by the side of the River Tolka.

Var β. mutica, Schultz. W. On trees at Westaston.

lævipila, Bridel. Bryol. Brit., p. 133 tab. 43. T. ruralis β. lævipila, Hook, and Grev. Barbula lævipila. Bryol. Europ., vol. 2, Monogr., p. 40, t. 164. W. and D. On trunks of trees. Common.

ruralis, Linn. Musc. Hib., p. 50. Bryol. Brit., p. 134, t. 12. Bryum rurale, Linn. Sp. Plant., 1, ed. 2, p. 1116. W. and D. Roofs of thatched cottages, and walls. Common.

papillosa, Wils. Bryol. Brit., p. 135, t. 44. Barbula papillosa, Rabenhor. Bryothec Europ., No. 455. W. On the trunks of trees at Powerscourt. D. Old Elm trees in the Botanic Garden, Glasnevin, and other places, frequent.

sinuosa, Wilson. M.S. fide Mitten in Seeman's "Journal of Botany," vol. 5, p. 327, (1867). D. On limestone rocks; also on the roots of trees in the Phœnix Park, and between Malahide and Portmarnock.

squarrosa, De Notr. Syllab., p. 180. Bryol. Brit., p. 126, t. 43. Pleurochœte squarrosa, Lindberg. Europ. Trichost., p. 47. W. On limestone rocks and sand-hills. Arklow and Woodenbridge. D. Sands at Portmarnock and Malahide.

Encalypta. Schreber.

streptocarpa, Hedw. Spec. Mus., p. 62, t. 10. Bryol. Brit., p. 145, tab. 13. D. On a mortared wall by the roadside leading to Finglass. Barren.

vulgaris, Hedw. Spec. Musc., p. 60. Bryol. Brit., p. 142., tab. 13. Hab. D. On the tops of walls near Donnybrook. Plentiful in an old limestone quarry near Cloghran, north of Dublin.

Cinclidotus. Beauvois.

fontinaloides, Beauv. Prodr., p. 52. Bryol. Brit., p. 139, t. 11. W. In rivulets and streams attached to stones. C. D. Common.

TRIBE 6.—ORTHOTRICHEÆ.

Orthotrichum. Hedwig.

anomalum, Hedw. Stirp. Crypt., tab. 37. Bryol. Europ., vol. 3. Monogr., p. 10, t. 210. D. On limestone rocks near the Dodder River at Sallygap. Very rare.

saxatile, Bridel. Bryol. Univers. 1, p. 275. Oanomalum, Wilson. Eng. Bot. Suppl., tab. 2696. Turn. Musc. Hib., p. 94. W. and D. Rocks and walls. Common.

Sturmii, Hornsch. et Hoppe. Crypt. Cent. 2 Decas, 2. Bryol. Europ., vol. 3, Monogr., p. 9, tab. 209. W. On rocks by the side of the lake at Luggelaw.

tenellum, Bruch. Bryol. Europ., vol. 3, Monogr. p. 15, t. 212. Bryol. Brit., p. 178, t. 45. W. On trees at Westaston. D. Near Ashtown.

stramineum, Hornsch. Bryol. Europ., vol. 3, Monogr., p. 23, t. 218. W. On trees near Seven Churches. Also at Westaston, and near Woodenbridge.

pumilum, Dickson. Crypt. Fasc. 4., p. 5. Bryol. Brit., p. 178, t. 45. D. On trees near Malahide.

pallens, Bruch et Schimp. Bryol. Europ., vol. 3., Monogr., p. 24, tab. 218. Bryol. Brit., p. 179, t. 45. W. On trees at Westaston.

rivulare, Turner. Musc. Hib., p. 96, t. 8. Bryol. Brit., p. 183, tab. 24. W. On rocks and stones in the Dargle River.

affine, Schrad. Bryol. Brit., p. 181, tab. 21, Hab. W. and D. On trees. Common.

fastigiatum, Bruch. Bryol. Brit., p. 180, tab. 45. D. On trunks of trees at Woodlands.

Lyellii, Hook. et Tayl. Muscol. Brit., p. 129, tab. 22. Bryol. Brit., p. 183, t. 22. W. On trunks of trees at Westaston, and Seven Churches.

diaphanum, Schrad. Spicil. Tl. Germ., p. 69. Bryol. Brit., p. 185, t. 21. W. and D. On trees. Common.

leiocarpum, Br. et Sch. Bryol. Europ., vol. 3, Monogr., p. 28, t. 220. O. striatum, Hedwig. Turn. Musc. Hib., p. 95. W. and D. On trees. Common.

pulchellum, Smith. Engl., Bot., tab. 1787. Bryol. Brit., p. 186, tab. 21. D. On trees at Ballinascorney Glen.

Drummondi, Hook. et Grev. In "Edin. Journ. of Science," vol. 1, p. 120. Bryol. Brit., p. 189, tab. 34. Ulota Drummondi, Bridel. W. On trunks; usually of young trees, frequent.

O. Hutchinsiæ, Hook. et Tayl. Muscol. Brit., p. 131, tab. 21. Bryol. Brit., p. 190, tab. 21. Ulota Hutchinsiæ, Briol. Ital., p. 290. W. On rocks among the mountains. Luggelaw and Lough Dan.

O. crispum, Hedw. Sp. Musc., p. 162. Bryol. Brit., p. 188, t. 21. W. On trees, and sometimes rocks frequent. D. Common.

phyllanthum, Bruch et Schimp. Bryol. Europ., vol. 3, Monogr., p. 30, tab. 223. W. On trees, and rarely on rocks. C. D. Common.

Zygodon. Hook. et Tayl.

viridissimus, Bridel. Bryol. Univ. 1, p. 592. Gymnostomum viridissimum, Smith. Eng. Bot., tab. 1583. W. On trees at Westaston. D. On rocks near Malahide, and on trees near Dunsink.

conoideus, Dickson. Crypt. Fasc. 4, tab. 11, fig. 2. Bryol. Brit., p. 193, t. 21. W. On the trunks of trees at Powerscourt.

TRIBE 7.—FUNARIEÆ.

Sphaerangium. Schimp.

muticum, Schimp. Synops. Muscor, p. 13. Phascum. muticum, Schreb. de Phasc., p. 8, t. 1, figs. 11–12. D. Damp sands at Malahide. Rare.

Physcomitrium. Bridel.

ericetorum, Br. et Schimp. Bryol. Europ., vol. 3, Monogr., p. 13, tab. 300. Gymnostomum fasciculare, Hook. et Tayl. Muscol. Brit., Ed. 2, p. 24. W. On heaths and on damp ground. Luggelaw and Lough Bray frequent. D. Glenmacnass and Glencree.

pyriforme, Br. et Schimp. Bryol. Europ., vol. 3, Monogr., p. 2, tab. 299. Hab. W. On damp ground. C. D. Common.

Entosthodon. Schwægr.

Templetoni, Schwægr. Suppl. tab. 13. Funaria Templetoni, Smith. Engl. Bot., t. 2524. Weissia Templetoni, Hook, and Tayl. Muscol. Brit., p. 77. W. On moist banks, and in crevices of wet rocks at Upper Lough Bray. C. Near Stepaside and other places by the sides of damp banks.

Funaria. Schreber.

hygrometrica, Hedw. Sp. Musc., p. 172. Bryol. Brit., p. 269. On banks and walls. C. D. Common.

TRIBE 8.—SPLACHNEÆ.

Splachnum. Br. et Schimp.

ampullaceum, Linn. Sp. Pl., p. 1572. Bryol. Brit., p. 289, t. 9. W. Boggy places and heaths, on the dung of herbivorous animals. Frequent. D. Killakee, and other mountainous parts.

sphæricum, Hedw. Stirp. 2, 46, t. 16. Bryol. Brit., p. 290, tab. 9. Hab. W. In similar places as the preceding, and often found growing with it, in both counties.

mnioides, Linn. fil. Meth. Musc., p. 6. Eng. Bot., t. 1589. Tetraplodon mnioides, Br. et Sch. Bryol. Europ., vol. 3, Monog., p. 5, t. 289. W. Moist places on the dung of Animals, Lugnaquilla. Rare.

TRIBE 9.—BARTRAMIEÆ.

Bartramia. Hedw.

fontana, Bridel. Bryol. Univer., 2, p. 20. Bryol. Brit., 279, t. 23. W. In wet boggy places. C. D. Common.

The Var. falcata, De Notaris, Wils. and Brid. W. On the ascent to Lugnaquilla.

calcarea, Br. et Sch. Bryol. Europ., vol. 4, Monog., p. 19, t. 325. W. Sides of streams in limestone districts, at Glenmalur.

caespitosa, Wils., fide Hunt, in "Memoirs of the Literary and Philosophical Society of Manchester," third series, vol. 3, p. 239, 1867. W. On damp ground Glenmalur, and near Kelly's Lake, rare.

rigida, Bals. et De Notr. Pugill., No. 1. Bryol. Brit., p. 278, t. 52. Hab. W. On shady rocks between Arklow and Woodenbridge.

ithyphylla, Bridel. Bryol. Univ., 2, p. 43. Eng. Bot., t. 1710. W. Rocks in mountainous parts. Lough Bray and Dargle.

pomiformis, Hedw. Sp. Musc. 164. Eng. Bot., t. 998. W. On dry banks at Seven Churches. D. Kelly's Glen.

arcuata, Bridel. Muscol. 4, p. 139. Eng. Bot., t. 1237. Bryol. Brit., p. 283, t. 23. W. On shaded rocks, Lough Bray.

TRIBE 10.—BRYEÆ.

Bryum. Hook. et Tayl.

acuminatum, Br. et Schimp. Bryol. Europ., vol. 4, Monogr., p. 21, t. 342, 343. Pohlia acuminata, Hornsch., in New Bot. Zeit. 2, p. 94. Hab. W. On the rocky sides of mountain streams, on Toole's rocks.

crudum, Schreb. Flor. Lips., p. 83. Webera cruda, De Notr., Briol. Ital., p. 424. W. Banks and wet rocks, Seven Churches and Lough Bray. D. Kelly's Glen.

nutans, Schreb. Spié. Flor. Lips., p. 81. Bryol. Brit., p. 225, t. 29. Hab. W. On heaths and sandy banks. C. D. Common.

annotinum, Hedw. Sp. Musc., t. 43. Bryol. Brit., p. 226, t. 47. Webera annotina, De Notr., Briol. Ital., p. 421. Hab. W. Banks and sand hills near the Seven Churches, in fruit. D. Portmarnock and other sand hills round the coast.

carneum, Linn. Sp. Pl., p. 1587. Bryol. Brit., p. 227. t. 29. Hab. W. shady moist banks. C. D. Common.

Wahlenbergii, Schwægr. Suppl., t. 70. Webera albicans De Notr., Briol. Ital., p. 420. Hab. W. Wet banks on sides of streams, at Lough Bray and Seven Churches. D. Kelly's Glen.

Warneum, Blandow. Bryol. Univ. 1, p. 675. Pohlia Warnensis, Schwægr., Suppl., t. 236. D. Sand hills near the sea, North Bull, Portmarnock and Malahide. Very local.

Maratii, Wils. Bryol. Brit. Addenda, p. 18, t. 32 b. Bryol. Europ., Suppl. 2, t. 640. D. Damp sandy ground, North Bull, Dublin. Rare.

alpinum, Linn. Syst. Pl., p. 949. Eng. Bot., t. 1263. Bryol. Brit., p. 231. W. Damp rocks Lough Bray.

pallens, Swartz. Musc. Suec., t. 4. Bryol. Brit., p. 233, t. 29. W. and D. In glens among the mountains, frequent.

uliginosum, Br. et Sch. Bryol. Europ., vol. 4, Monogr., p. 18, t. 339. D. Marshy ground on the mountains, very rare.

pendulum, Schimp. Synops. Muscorum, p. 348. B. cernuum, Bryol. Europ., vol. 4. Monogr., p. 14, t. 331. Bryol. Brit., p. 235, t. 47. D. Walls and gravelly places, near Baldoyle, and on a wall in the Phœnix Park.

inclinatum, Br. et Schimp. Bryol. Europ. Monogr., p. 16, t. 334. D. Peaty banks among the mountains, and on the tops of walls, frequent.

intermedium, Bridel. Bryol. Univ. 1, p. 632. Bryol. Brit., p. 237, t. 49. D. Tops of walls and sand hills, near Malahide and other places frequent.

bimum, Schreb. Sp. Flor. Lips., p. 83. B. ventricosum, Dicks. Pl. Crypt., Fasc. 1, p. 4. W. Marshy and boggy places. C. D. In similar places. Common.

torquescens, Br. et Schimp. Bryol. Europ. vol. 4, Monogr. p. 49, tab. 358. D. On the top of a wall at Sheep-hill Demesne, also at Ashtown.

capillare, Hedw. Sp. Musc. p. 131. Bryol. Brit. p. 242, t. 29. W. On walls and rocks. C. D. Common.

Donianum, Greville, in Linn. Soc. Transact., vol. 15, p. 345, t. 3, f. 6. B. platyloma, Bryol. Europ., vol. 4, Monogr, t. 58, p. 366. D. On the north side of the Hill of Howth, on a damp bank by the side of one of the new roads. Barren.

cœspititium, Linn, Sp. Pl., p. 1586. Bryol. Brit. p. 243. W. On walls and waste ground. C. D. Common.

erythrocarpum, Schwægr. Suppl. tab. 70. B. sanguineum, Bridel., Bryol. Univ., 1, p. 971. Bryol. Brit., p. 243, tab. 50. D. Heaths and dry banks, Hill of Howth.

atropurpureum, Web. et Mohr. Ind. Musc. B. bicolor, Turn., Musc. Hib. Partly. W. Banks and waste places at Seven Churches. D. On the Hill of Howth.

julaceum, Smith. Fl. Brit., p. 1357. Eng. Bot., tab. 2270. W. Marshy places and wet rocks, Lough Bray and Powerscourt Waterfall.

argenteum, Linn. Sp. Pl., p. 1586. Eng. Bot., tab. 1602. W. and D. Banks and hardened ground. Common.

Aulacomnion. Schwægr.

palustre, Schwægr. Suppl., tab. 226. Minum palustre, Hedw. Sp. Musc., p. 188. Bryum palustre, Eng. Bot., t. 391. W. Wet heaths and marshy places, Lough Bray.

Leptobryum, Wilson.

pyriforme, Wilson. Bryol. Brit., p. 219, tab. 27. Bryum pyriforme, Rabenhor, Bryothec. Europ., No. 93. Hab. D. Shady, damp banks and rocks on the mountains. It also grows in great abundance on the mould of flower-pots in the Botanic Gardens, Glasnevin, both in conservatories and houses, which are seldom under 65° Fahr.

Minum, Linn.

undulatum, Hedw. Sp. Musc., p. 195. Bryum ligulatum, Eng. Bot., t. 1449. W. Woods, and damp, shady banks. C. D. C. Rare in fruit.

punctatum, Hedw. Sp. Musc., p. 193. Bryum punctatum, Eng. Bot., tab. 1183. W. Marshy places. C. D. Common.

hornum, Linn. Sp. Pl., p. 1576. Bryum hornum, Turn. i., or Fl. Hib., p. 128. W. Woods and shady banks. C. D. Common.

rostratum, Schwægr. Suppl., tab. 79. Bryum cuspidatum, Turner, Muscol. Hib., p. 131. Eng. Bot., tab. 1474. W. Moist, shady rocks, Dargle River.

Amblyodon, P. Beauvois'.

dealbatus, P. Beauv. Prodr., p. 41. Bryum dealbatum, Dickson, Pl. Crypt. Fasc., 2, tab. 5, f. 3. D. Among the sandhills between Malahide and Portrane.

TRIBE 11.—HOOKERIEÆ.

Daltonia, Hook. et Tayl.

splachnoides, Hook. and Tayl. Muscol. Brit., p. 139. Bryol. Brit., p. 418, tab. 22. Neckera splachnoides, Smith, Eng. Bot., tab. 2564. D. Moist, shady rocks, Secghane Mountain. Rare. Dr. Taylor.

Hookeria, Smith.

lucens, Dill. Musc., tab. 34, f. 10. Eng. Bot., tab. 1902. W. Damp banks by the sides of rivulets. C. D. Common.

TRIBE 12.—NECKEREÆ.

Hedwigia, Ehrh.

ciliata, Hedw. St. Crypt., l. tab. 40. Bryol. Brit., p. 146, tab. 6. Anictangium ciliatum, Turn., Muscol. Hib., p. 11. W. On exposed rocks. C. D. In similar places. C. The varieties γ. viridis, of Wilson's "Bryologia Britannica," and δ. secunda, grow at Lough Bray and Luggelaw, Wicklow.

Hedwigidium, Br. et Schimp.

imberbe, Br. et Sch. Bryol. Europ., vol. 3, Monogr., p. 3, tab. 274. Anictangium imberbe, Hook. and Tayl., Muscol. Brit., p. 27. W. On the faces of moist rocks, at Lough Bray and Lugnaquilla.

Leucodon, Schwægr.

sciuroides, Schwægr. Supp., tab. 125, fig. 10. Bryol. Brit., p. 313, tab. 20. D. Near the Longford Bridge, Royal Canal. Rare. Abundant in parts of county Meath.

Antitrichia, Bridel.

curtipendula, Bridel. Br. Univ., 2, p. 222. Neckera curtipendula, Turn., Muscol. Hib., p. 102. Eng. Bot., tab. 1444. W. On the trunks of alder trees, Upper Lough Bray. Fruit.

Cryphæa, Bridel.

heteromalla, Bridel. Bryol. Univ., 2, p. 250. Neckera heteromalla, Eng. Bot., tab. 1180. W. Trunks of trees. C. D. C.

Fontinalis, Dillenius.

antipyretica, Linn. Sp. Plant., p. 1571. Bryol. Brit., p. 423, tab. 22. Hab. W. Attached to stones in rivulets. C. D. Common.

squamosa, Linn. Sp. Pl., 1591. Bryol. Brit., p. 424, tab. 22. W. Lakes and rivulets; frequent. D. In the mountain streams; frequent.

Neckera. Hedw.

pumila. Hudson. Fl. Angl., p. 468. Bryol. Brit., p. 413, tab. 22. W. On trunks of trees, Westaston and Powerscourt.

Homalia. Schimp.

complanata. Linn. Sp. Pl., p. 1588. Hypnum complanatum, Turn. Musc. Hib. p. 144. W. Trunks of trees, walls, and rocks frequent. D. In similar places frequent.

Trichomanoides. Dill. Musc., tab. 34, fig. 7. Omalia trichomanoides Bryol. Brit., p. 410, tab. 24. Hypnum trichomanoides Turn. Musc. Hib. p. 145. W. Trunks of trees and on rocks. C. D. Common.

TRIBE 13. STEREODONTEÆ.

Plagiothecium. Bryol. Europ.

undulatum. Linn. Bryol. Europ., vol. 5, Monogr. p. 17, tab. 506. Hypnum undulatum. Bryol. Brit., p. 405, tab. 24. W. Woods and banks frequent. D. Frequent.

sylvaticum. Linn. Bryol. Europ., vol. 5. Monogr., p. 14, tab. 503. Hypnum sylvaticum. Bryol. Brit., p. 406, tab. 24. W. Damp ground, Luggelaw Woods.

elegans. Hooker. Musc. Exot., tab. 9. Hypnum elegans. Wilson, Bryol., Brit., p. 408, tab. 59. W. Damp shady banks and rocks, at Powerscourt Waterfall.

denticulatum. Dill. Bryol. Europ., vol. 5, Monogr., p. 12, tab. 501–502. Hypnum denticulatum. Bryol. Brit., p. 407, tab. 24. W. Woods and banks frequent. D. Frequent.

pulchellum. Dicks. Bryol. Europ., vol. 5. Monogr., p. 9, tab. 497. Hypnum pulchellum, Bryol. Brit., p. 403, tab. 24. W. Wet banks among rocks, Powerscourt Waterfall, and Upper Loughbray.

Cylindrothecium. Br. et Schimp.

concinnum. De Notr. Mantiss. No. 18. C. Montagnei, Bryol. Europ., vol. 5. Monogr., p. 6, tab. 465, Bryol. Brit., p. 327, tab. 54. D. Banks and sand hills, near Sallygap, sandhills between Malahide and Portrane.

TRIBE 14. HYPNEÆ.

Pterogonium. Schwartz.

gracile, Schwartz. Musc. Suec., p. 26. Bryol. Brit., p. 321, t. 14. W. Rocks and on large stones, Lough Bray aud Luggelaw. D. Killakee Glen.

filiforme. Schwægr. Suppl. 1, p. 100, Bryol. Brit., p. 320, t. 14. W. Dry rocks in shaded woods. C. D. Common.

Isothecium, Bridel.

myurum, Dill. Musc., tab. 41, f. 50. Hypnum curvatum, Turner, Musc., Hib., p. 139. W. On trees and rocks. C. D. C.

Homalothecium, Schimp.

sericeum, Linn. Bryol. Europ., vol. 5. Monogr., p. 3, tab. 456. Hypnum sericeum. Turn., Musc. Hib. p. 138. Engl. Bot., tab. 1445. W. On trunks of trees, walls, and rocks. C. D. Common.

Thamnium, Schimp.

alopecurum, Linn. Bryol. Europ., vol. 5. Monogr., p. 4, tab. 518. Isothecium alopecurum, Bryol. Brit., p. 324, tab. 25. W. By the sides of rivulets, and in moist woods, frequent. D. Frequent.

Heterocladium, Schimp.

heteropteron, Br. et Schimp. Bryol. Europ., vol. 5. Monogr., p. 4, t. 480. Hypnum heteropteron, Bryol. Brit., p. 369, t. 26. W. Moist rocks, and broken ground frequent. D. Frequent.

Anomodon, Hook. et Tayl.

viticulosa, Hook. and Tayl. Muscol. Brit., Ed. 2, p. 138. Neckera viticulosa Turn. Musc. Hib. p. 103. W. Limestone rocks and on walls, frequent. D. Frequent.

Thuyidium, Schimp.

abietinum, Linn. Sp. Pl., p. 1591. Hypnum abietinum, Bryol. Brit., p. 377, tab. 25. D. On Portmarnock sand hills, also at Malahide and Portrane, rare.

tamariscinum, Hedw. Sp. Musc., p. 261, tab. 67, figs. 1–5. Hypnum tamariscinum, Bryol. Brit., p. 380, tab. 57. W. Woods and shady banks. C. D. Common.

Hypnum, Linn et Dillen.

Sect. Brachythecium, Bryol. Europ.

Lutescens, Hudson. De Notr., Briol. Ital., p. 113. W. Rocks and sand hills, near the sea. C. D. Common.

albicans, Dill. Bryol. Europ., vol. 6. Monogr., p. 19, t. 553. Hypnum albicans, Bryol. Brit., p. 337, t. 25. D. On sand hills near the sea. Common.

glareosum, Br. et Sch. Bryol. Europ., vol. 6, Monogr., p. 19, t. 552. W. On grassy banks, frequent. D. Frequent.

rivulare, Br. et Schimp. Bryol. Europ., vol. 6, Monogr., p. 13, t. 549. W. On dripping rocks, between Arklow and Woodenbridge. D. Ballinascorney Glen, and Kelly's Glen.

illecebrum, Schwaegr. De Notr., Briol. Ital., p. 113. Hypnum illecebrum, Bryol. Brit., p. 343, tab. 35. D. Banks and rocks, Ballinascorney Glen, Killiney, and on the Hill of Howth.

velutinum, Linn. Sp. Plant., p. 1595. Hypnum velutinum, Bryol. Brit., p. 342, tab. 26. W. On stones, old walls and banks. C. D. Common.

populeum, Hedw. Sp. Musc., tab. 70, figs. 1–6. Hypnum populeum Bryol. Brit., p. 341, tab. 24. .W. On rocks, walls, and trees. C. D. Common.

plumosum, Swartz. Muscol. Suec., p. 66. Hypnum plumosum. Bryol. Brit., p. 240, tab. 25. W. Wet rocks and banks by the margins of the mountain streams. C. D. In similar places. C.

Mildeanum, Schimp. Rabehor, Bryothec, Europ., No. 772. Hypnum salebrosum, Bryol. Brit., p. 338, tab. 53 (in part). D. Grassy banks and sand hills, between Malahide and Portrane, rare.

rutabulum, Linn. Sp. Pl., p. 1590. Hypnum rutabulum, Bryol. Brit., p. 345, tab. 26. W. Trees, rocks, walls, and banks. C. D. Common.

Sect. Rhynchostegium, Bryol. Europ.

rusciforme, Weiss. Bryol. Europ., vol. 5, Monogr, p. 11, tab. 515–516. Hypnum ruscifolium, Bryol. Brit., p. 354, tab. 26. W. About waterfalls on rocks. C. D. Common.

confertum, Dicks. Crypt. Fasc. 4, tab. 11, fig. 4. Hypnum confertum Bryol. Brit., p. 355, t. 26. W. On trunks of trees and on stones, walls, &c. C. D. Common.

megapolitanum, Blandow. Bryol. Europ., vol. 5, Monogr, p. 8, tab. 511. Hypnum megapolitanum, De Notr. Mant., No. 22. D. Sand hills. Between Portrane and Malahide.

murale, Dill. Musc., tab. 41, f. 52. Hypnum murale Bryol. Brit., p. 356, tab. 24. D. On walls and stones, at St. Margaret's, Howth, and in the Botanic Garden, Glasnevin.

tenellum, Dicks. Crypt. Fasc., p. 4., tab. 11, f. 12. Hypnum tenellum, Bryol. Brit., p. 35, tab. 24. W. On rocks and old walls frequent. D. Frequent.

striatum, Schreb. Fl. Lips., p. 91. Bryol. Ital., p. 76. Hypnum striatum Bryol. Brit., p. 352, tab. 26. D. Grassy banks in the Botanic Gardens, Glasnevin.

striatulum, Spruce. Bryol. Ital., p. 78. Hypnum striatulum, Bryol. Brit., p. 352, tab. 55. W. In woods at the Devil's Glen.

myosuroides, Linn. Sp. Plant, p. 159. Hypnum myosuroides, Turner, Musc. Hib., p. 140. W. On shady rocks, trunks of trees, &c. C. D. Common.

strigosum, Hoffm. Deutsch, Flor. 2, p. 76. Hypnum strigosum, Bryol. Brit., p. 353, tab. 55. Hab. D. At the roots of trees and on banks near Sallygap, the only known locality.

piliferum, Schreb. Fl. Lips., p. 91, Hypnum piliferum, Bryol. Brit., p. 347, t. 25. W. Woods and shady banks. C. D. C.

praelongum, Dill. Musc., tab. 35 f. 15. A. Hypnum praelongum, Bryol. Brit., p. 348, tab. 25. W. Moist shady banks between Woodenbridge and Arklow. C. Var β at Lough Bray. D. Shady banks. Common.

Swartzii, Turner. Hypnum Swartzii, Musc. Hib., p. 151, tab. 14, fig. 1. D. Shady banks. C. But rare in fruit.

hians, Hedw. Sp. Musc., p. 272, tab. 70, figs. 11–14. Hab. D. On the rocky sides of streams, Ballinascorney Glen, and Hillbrook, very rare.

pumilum, Wilson. De Notr. Bryol. Ital. p. 87. Hypnum pumilum, Bryol. Brit., p. 35, tab. 55. D. About the roots of trees in the Botanic Garden, Glasnevin.

Sect. Amblystegium, Bryol. Europ.

serpens, Dill. Bryol. Europ., vol. 6. Monogr., p. 9, t. 564. Hypnum serpens, Bryol. Brit., p. 362, tab. 24. W. On walls, rocks, and among the roots of trees. C. D. Common.

riparium, Linn. Bryol. Europ., vol. 6. Monogr., p. 14, t. 570–571. Hypnum riparium, Bryol. Brit., p. 364, tab. 24. W. On wood, and stumps of trees by the sides of rivers. C. D. C.

Sect. Limnobium, Bryol. Europ.

palustre, Linn. Bryol. Europ., vol. 6. Monogr., p. 2, tab. 574–575. Hypnum palustre, Schimp. Synops. Muscor. p. 64. W. On rocks in streams frequent. D. In similar places frequent.

ochraceum, Turner. Bryol. Europ., vol. 6. Suppl. t. 580. Hypnum ochraceum, Turner in Herb. W. On stones by the sides of the mountain rivulets at Lough Bray. D. Side of the stream in Kelly's Glen, fruit, May.

Sect. Hypnum, Bryol. Europ.

cordifolium, Hedw. St. Crypt, p. 4, tab. 37, vol. 6. Monogr. p. 47, t. 617. W. Bogs and marshy places. C. D. Common.

stramineum, Dicks. Bryol. Europ., vol. 6. Monogr. p. 49, tab. 617. D. Marshy heaths and wet sandy places. Kelly's Glen, Fruit.

cuspidatum, Dill. Musc., tab. 39, fig. 34. Eng. Bot. tab. 2407. W. Marshy ground. C. D. Common.

purum, Linn. Sp. Plant, p. 1594. Bryol. Brit. p. 376, tab. 24. W. Shady banks, among rocks and stones. C. D. Common.

Schreberi, Willd. Fl. Berol, p. 325. Bryol. Brit., p. 376, tab. 24. W. Heaths and banks. C. D. Common.

Lindbergii, Mitten. In Seeman's Journal of Botany, vol. 2, p. 122, 1864. H. arcuatum, Lindberg. In efversight of K. Vetenskaps Akad. Forhandlingar, 1861. W. Damp sandy ground, near Lough Bray and Lugnaquilla. (Barren).

scorpoides, Linn. Sp. Pl. 1592. Bryol. Brit. p. 400, tab. 27. W. Bogs and marshy places, frequent. D. Frequent.

lycopodioides, Necker. Bryol. Europ., vol. 6. Monogr. p. 45, tab. 613–614. W. Bogs and marshes frequent. D. Frequent.

vernicosum, Lindberg. Hypnum aduncum, Hedw., fide Wilson in "Naturalist," 15th June, 1865. W. Bogs and in marshes frequent. D. Frequent.

revolvens, Swartz. Bryol. Brit. p. 388, tab. 58. D. Marshes and bogs. Seecaun and Seefin Mountains.

uncinatum, Hedw. Bryol. Brit. p. 394, tab. 26, Eng. Bot. tab. 1600. W. On rocks and on the roots of trees at Luggelaw. D. Killake Glen.

exanulatum, Gumb. Hypnum aduncum Bryol. Brit., p. 389, tab. 26. D. Marshy places, Howth, and near Stepaside.

fluitans, Dill. Bryol. Brit. p. 387, tab. 58. W. Marshes and lakes among the mountains frequent. D. In similar places frequent.

Kneiffii, Schimp. Synops. Musc., p. 605. Bryol. Brit. p. 390, tab. 58. W. Swampy places near Arklow. Sand hills between Malahide and Portrane.

commutatum, Dill. Bryol. Europ., vol. 6. Monogr., p. 38, tab. 607–608. W. Boggy places. C. D. Common.

filicinum, Linn. Bryol. Europ., vol. 6, Monogr., p. 40, tab. 609. W. Wet rocks, and on the margins of streamlets. C. D. C.

molluscum, Hedw. St. Crypt., p. 4, tab. 22. Bryol. Brit. p. 396, tab. 27. W. Among damp limestone rocks. C. D. Common.

cupressiforme, Dill. Musci. Tab. 37, fig. 33. Bryol. Brit. p. 397, tab. 27. W. Rocks, trees, and on the ground. C. D. Common.

polygamum, Br. et Schimp. Wils. Bryol. Brit., p. 364, tab. 56.

polymorphum, Hook and Tayl. in Herb. Grev. D. Damp places among the sand hills at Portmarnock and Malahide. Variety β stagnatum. H. stagnatum (Wils. M.S. in marshy ground near Arklow, and other places on the coast of Wicklow.

stellatum, Dill. Musc. tab. 39, fig. 5. Bryol. Brit. p. 366, tab. 26. W. Bogs and marshy places, frequent. D. Frequent.

chrysophyllum, Bridel. Mant. Musc., p. 175. Bryol. Brit. p. 366, tab. 26. W. Sand hills near the sea, frequent. D. Frequent.

elodes, Spruce. London Journal of Botany, vol. 4, April, 1845. H. polymorphum Flor. Hib., p. 44. W. Marshy and boggy ground near Black Castle. D. In a bog near Killiney.

Sect. Hylocomium, Bryol. Europ.

splendens, Hedw. Sp. Musc., tab. 67, f. 49. W. Woods and banks. C. D. Common.

brevirostrum, Ehrh. Pl. Exsicc, No. 85. Bryol. Brit., p. 383, tab. 57. W. In woods in the mountainous parts frequent. D. Frequent.

flagellare, Dicks. Crypt. Fasc, 2, p. 12. Hypnum flagellare, Bryol. Brit., p. 384, tab. 57. W. Rocks and stones by the sides of the mountain streams Lough Bray. D. Kelly's Glen.

triquetrum, Dill. Bryol. Europ., vol. 5. Monogr. p. 8, tab. 491. Hypnum triquetrum, Bryol. Brit. p. 385, tab. 26. W. Woods and bushy places. C. D. Common.

loreum, Dill. Musc., tab. 39, f. 38-40. Hypnum loreum. Bryol. Brit., p. 386, tab. 26. W. Woods and bushy places. C. D. Common.

squarrosum, Dill. Musc., tab. 39, f. 38 and 39. Hypnum squarrosum, Bryol. Brit. p. 386, tab. 26. Hab. W. Woods and heathy places. C. D. Common.

Tribe 15.—Skitophylleæ.

Fissidens. Hedw.

adiantoides, Hedw. St. Crypt. p. 3, tab. 26. Dicranum adiantoides. Turn. Musc. Hib. p. 57. W. On wet rocks, banks, and pastures. C. D. Common.

taxifolius, Hedw. Sp. Musc., tab. 39. Dicranum taxifolium. Swartz. Musc. Suec. p. 31. W. Moist shady banks. C. D. C.

tamarindifolius, Turner. Musc. Hib., p. 55. Bryol. Brit., p. 308, tab. 53. D. Moist bank near Cullen's Wood. Dr. W. Stokes. Rare.

viridulus, Linn. Wilson, Bryol. Brit., p. 303, tab. 53. Dicranum viridulum, Swartz. D. On shady, moist banks, Howth. Rare.

bryoides, Hedw. St. Crypt, p. 3, tab. 9. Bryol. Brit., p. 304, tab. 16. W. On moist, shady banks; frequent. D. Frequent.

Tribe 16.—Polytricheæ.

Catharinea, Ehrh.

undulata, Web. et Mohr. Bot. Taschenb., 216. Atrichum undulatum, P. Beauv., Rabenhor., Bryothec. Europ., No. 282. W. Damp, shady places. C. D. Common.

Oligotrichum, De Cand.

hercynicum, De Cand. Flor. Gallic. Bryol. Brit., p. 205, tab. 10. Atrichum hercynicum, P. Beauv. W. Banks where the soil is bare, Lugnaquilla Mountain, and between Woodenbridge and Arklow.

Pogonatum, Bridel.

alpinum, Rohl. Deutchl. Fl., Ed. 3, p. 59. Polytrichum alpinum, Linn., Sp. Pl., p. 1109. W. Fissures of rocks, on the ascent to Lugnaquilla Mountain.

urnigerum, Bridel. Bryol. Univ., 2, p. 124. Polytrichum urnigerum, Linn., Sp. Pl., p. 1109. W. Moist banks on the mountains. C. D. Common.

subrotundum, Lindberg, in Hartm. Skand. Fl., Ed. 2, p. 44. Polytrichum subrotundum, Huds. Fl. Angl., Ed. 1, p. 400. W. Ditch banks, Lough Bray. D. Hill of Howth.

nanum, Weiss. Pl. Crypt. Fl. Gott., p. 173. Polytrichum aloides, Hedw., St. Crypt., 1, p. 37. Hab. W. Damp banks and rocky places in the mountainous parts. C. D. In similar places. Common.

Polytrichum, Bridel.

commune, Linn. Sp. Pl., 1, p. 1100. Bryol. Brit., p. 211, tab. 10. Hab. W. Marshy woods, moors, &c. C. D. Common.

juniperinum, Willd. Fl. Berol. Prodr., p. 305. Bryol. Brit., p. 213, tab. 10, fig. f. Hab. W. Heathy places, tops of turf, walls, &c. C. D. C. The variety β. strictum, P. strictum, Menzies, in Linn. Soc. Trans., vol. 4, tab. 5, fig. 7, and the var. γ. alpestre, P. alpestre, Schwægr., Suppl., tab. 97, occur occasionally in both counties.

piliferum, Schreb. Spicil. Fl. Lips., p. 74. Bryol. Brit., p. 213, tab. 10. W. Tops of turf, walls, dry heaths, &c. C. D. C.

gracile, Dicks. Eng. Bot., tab. 1827. W. Turf bogs, &c. C. D. C.

attenuatum, Menzies, in Linn. Soc. Trans., vol. 4, p. 72. Hab. W. Damp, shady banks, at Powerscourt Waterfall.

TRIBE 18.—SPHAGNEÆ.

Sphagnum, Dillenius.

cymbifolium, Ehrhart. S. latifolia, Turner, Musc. Hib., p. 5. W. On bogs and marshes; frequent. D. Frequent.

fimbriatum, Wilson. Bryol. Brit., p. 21, tab. 60. Pire, 1, c., No. 3. Hab. W. Marshes and bogs, at Lough Bray. Rare.

rubellum, Wilson. Bryol. Brit., p. 19, tab. 60. Hab. W. Wet banks; frequent. D. Frequent.

squarrosum, Persoon. Wils. Bryol. Brit., p. 23, tab. 4. W. Bogs and marshes. C. D. Common.

subsecundum, Nees Von Esenbeck. Sturm. Deutschl. Flor. Crypt., Fasc. 17, 1820. S. contortum, var. β. secundum, Wilson, Bryol. Brit., p. 22, tab. 60. W. On wet banks and turf bogs, Lough Bray. D. Hill of Howth.

Var. β. contortum, S. contortum, Schultz-Wilson, Bryol. Brit., p. 22, tab. 60, has been collected at Lough Bray, Wicklow, and on the Hill of Howth, Dublin.

acutifolium, Ehrhart. Wilson, Bryol. Brit., p. 20, tab. 4. W. Wet bogs. C. D. Common.

tenellum, Ehrhart. Bridel, Bryol. Univ. 1, p. 4. W. Wet woods and damp heaths, at Glenmalur. Rare.

TRIBE 19.—ANDREÆACEÆ.

Andreæa, Ehrhart.

alpina, Dill. Wils., Bryol. Brit., p. 11, tab. 8. Hab. W. On mountain rocks, at Upper Lough Bray and Glenmalur. D. Killakee Glen and Killiney.

petrophila, Ehrhart. Br. et Schimp., Bryol. Europ., vol. 2, Monogr., p. 13, tab. 623, 625. W. On rocks, Lugnaquilla Mountain.

rupestris, Turner. Muscol. Hib. p. 14. A. Rothii, Bryol. Brit., p. 12, tab. 8. W. On the mountain rocks. C. D. Common.

crassinervia, Bruch. Braithwaite, in Seeman's "Journal of Botany," vol. 8, p. 95, 1870. Hab. W. Mountain rocks, at Upper Lough Bray.

LIST OF HEPATICÆ WHICH ARE FOUND IN THE COUNTIES OF DUBLIN AND WICKLOW, WITH THEIR PRINCIPAL LOCALITIES,

BY

DAVID MOORE PH.D., F.L.S.

[Read March 18, 1878.]

The other Irish species which are not included in the Dublin and Wicklow List will be found described in the "Report on Irish Hepaticæ," by D. Moore. Royal Irish Academy Proceedings, vol. ii., Series 2, p. 591.

SECTION 1.—MARCHANTIACEÆ.

Family 1.—*Marchantieæ.*

Marchantia, Linn.

polymorpha, Linn. In moist situations, and sometimes in dry places. W. Frequent. D. Especially abundant on the surface mould of pots in the Botanic Gardens, where it is frequently subjected to high temperatures, under which treatment both ♂ and ♀ receptacles are abundantly produced.

Conocephalus, Neck. Dumort.

conicus, Neck. Dumort. Fegatella conica. G. L. et N. Synop. Hepat., p. 546. Marchantia conica, Eng. Bot., tab. 504. W. Damp, shady places. D. Common.

Preissia. Nees.

commutata, Nees. Marchantia commutata, Lindenb. Hep. Europ., p. 101. D. On damp sandy ground near the sea, at the North Bull. Rare.

Dumortiera. Nees.

irrigua, Nees. Marchantia irrigua, Wilson, in Hook Engl. Fl., 5, 1, p. 106. Hygrophila irrigua, Taylor in Fl. Hib., p. 54. W. Sheltered, rocky recesses, where water is constantly trickling over, at Altadore glen, near Delgany; also at a small waterfall near Luggelaw.

Asterella. Beauv.

hemisphaerica, Beauv. Marchantia hemisphærica, Linn., Sp. Pl. 1604. D. On damp, sandy ground, at the North Bull, near the sea.

Lunularia. Micheli.

cruciata, Linn. Dumort; Lunularia vulgaris, Micheli, Nov. Gen. 4, tab. 4; Marchantia cruciata, Linn., Sp. Pl. 1604. W. Damp ground at Altadore glen, near Delgany.

FAMILY 2.—RICCIEÆ. Mich.

Riccia. L.

glauca, Linn. Sp. Pl. 1605. W. On damp ground. D. Common.

SECTION II.—JUNGERMANNIACEÆ.

Sub-Tribe 1.—Frullanieæ.

Frullania. Raddi.

dilatata, Linn., Dumort. Jungermannia dilatata. Linn., Sp. Pl., p. 1600. Frullania minor, Raddi, Jung, in Mem. Modena, 18, p. 21, t. 2, fig. 3. W. On the trunks of trees. D. Common.

tamarisci, Mich. L., Dumort. Jungermannia tamarisci L., Sp. Pl. 1. ed 2, p. 1134. Frullania major, Raddi, in Att. Soc. Sc. Modena, 18, p. 20. W. On the trunks of trees. D. Common.

germana, Taylor. Jungermannia germana Tayl., in Trans. Bot. Soc. Edin, vol. 2, p. 43. F. tamarisci, var. ε. germana. Carring. Irish Hepat., p. 457. W. On rocks, and on trees, Lough Bray.

Lejeunea, Libert.

hamatifolia, Hook. Dumort. Jungermannia hamatifolia, Hook. Brit. Jung., t. 51. W. On the trunks of trees and on bare rocks, near Powerscourt. D. At Woodlands, near Clonsilla.

echinata, Hooker. Taylor. Jungermannia hamatifolia, var. β. echinata, Hook., Brit. Jung., 51. Lejeunea calcarea, Libert., Ann. Gen. Sc. Phys., 6, p. 373, t. 96, fig. 1. D. On limestone rocks, and parasitic on the larger mosses, especially the genus Thamnium, at Woodlands, near Clonsilla.

minutissima, Smith. Dumortier. Jungermannia minutissima, Smith, Engl. Bot., t. 1633. Jungermannia ulicina, Taylor, in Trans. Bot. Soc., Ed. 1, p. 115. W. On the stems of trees and on mosses, at Luggelaw and Powerscourt. D. Near Woodlands.

serpyllifolia, Mich., Dicks. Libert. Jungermannia serpyllifolia, Dicks., Pl. Crypt. Brit., 4, p. 19. W. On the trunks of trees and damp banks. D. Common.

Mackaii, Hooker. Jungermannia Mackaii, Hook., Brit. Jung, t. 53. Phragmicoma Mackaii, Dumort., Comm. Bot., p. 112. D. Near Woodlands.

Radula, Dumortier.

complanata, Linn. Dumortier. Jungermannia complanata, Linn., Sp. Pl.; Hook. Brit. Jung., t. 81. W. On trees and rocks. D. Common.

Porella, Dillenius.

lævigata, Rupp., Schrad. Lindberg. Jungermannia lævigata, Hook., Brit. Jung, t. 35. Madotheca lævigata, Dumort., Comm. Bot., p. 111. W. Damp rocks, Lough Bray.

platyphylla, Linn. Lindberg. Jungermannia platyphylla, L., Sp. Pl., 1 ed., p. 1134. Madotheca platyphylla, Dumort., Comm. Bot., p. 111. W. On rocks, trunks of trees, and moss-covered banks. D. Common.

Thuja, Dicks. Jungermannia Thuja, Dicks., Pl. Crypt., 4, p. 19. W. On rocks and stones.

SUB-TRIBE 2.—PLEUROZIEÆ.

Pleurozia, Dumortier.

cochleariformis, Dumortier. Jungermannia cochleariformis, Weiss., Pl. Crypt., p. 123. Physiotium cochleariformis, Nees., Europ. Leberm., 3, p. 79. W. On wet, boggy places, about Upper Lough Bray. D. Moors about the mountains.

SUB-TRIBE 3.—LEPIDOZIEÆ.

Lepidozia, Linn. Dumortier.

reptans, Linn. Sp. Pl., 1599. Hook., Brit. Jung., t. 75. Mastigophora reptans, Nees., Leber. Europ., 3, p. 31. W. Woods and bushy banks. D. Common.

cupressina, Sw. Dum. Jungermannia reptans, β. pinnata, Hook., Brit. Jung., t. 75. L. tumidula, Tayl., in G. L. et N. Synop. Hepat., p. 206. W. Damp rocks and banks, at Lough Bray.

Bazzania. Bennett Gray.

trilobata, Mich., L. B. Gr. Jungermannia trilobata, Linn, Sp. Pl. 1599. Mastigobryum trilobatum, G. L. et N. Synop. Hepat., p. 230. Jungermannia radicans, Hoff. Germ. 2, p. 87. W. Mountain woods, Upper Lough Bray, and Seven Churches. D. Killakee Glen.

Odontochisma. Dumortier.

sphagni, Dicks. Dumortier. Jungermannia sphagni, Dicks. Fasc. Pl. Crypt. Brit. 1, p. 6. Sphagnocetis communis, Nees, in G. L. et N. Synop. Hepat., p. 148. W. In bogs, among Sphagnum. Frequent. D. Killakee Glen, and other boggy places.

Cephalozia. Dumortier.

elachista, Jack. Jungermannia elachista Jack, in Gottsche et Rabenhor. Hepat. Europ., exsic. No. 574. W. On moist banks at Lough Bray. Very rare. S. O. Lindberg.

byssacea, Roth, Dumort. Jungermannia byssacea, Roth. Fl. Germ. 3, p. 387. Hook. Brit. Jung., t. 12. W. On paths in woods, and on bare crags. D. C.

bicuspidata, Linn, Dumort. Jungermannia bicuspidata Linn, Sp. Pl. 158. Hook. Brit. Jung., t. 11. W. On heaths and banks. D. Common.

uliginosa, Spruce. W. Moist banks, Lough Bray. D. Killakee Glen. (New to Ireland—" not previously published as Irish.")

connivens, Dicks. Jungermannia connivens, Dicks, Pl. Crypt. fasc. 4, p. 19, tab. 2, fig. 15. Hook. Brit. Jung., tab. 15. Blepharostoma connivens, Dumort, Rev. Jung., p. 18. W. Wet banks, among mosses. D. Wet places. C.

Var. *a*. conferta minor. On rotten wood. Frequent in both counties.

Cephalozia. Dumortier.

Var. β. sphagnorum, Hook. Brit. Jung, t. 15, 3. Frequent among Sphagnum, about Lough Bray. W.

catenulata, Huebener, Lindb. Jungermannia catenulata, Huebener. Hepat Germ., p. 169. Jungermannia reclusa, Taylor in Trans. Bot. Soc. Edin. 11, p. 44. W. On shady, damp banks, about Lough Bray, and elsewhere. D. Killakee Glen, and elsewhere. Common.

Lophocolea. Dumortier.

bidentata, Linn., Dumort. Jungermannia bidentata Sm. Eng. Bot., t. 606. Hook. Brit. Jung., t. 30. W. D. C.

spicata, Taylor in G. L. et N. Synop. Hepat., p. 167. Cook. Brit. Hepat., p. 15, n. 75, fig. 113. W. On shady, damp rocks; among mosses at Altadore Glen, near Delgany.

Chiloscyphus. Corda.

polyanthos, Corda. Jungermannia polyanthos Linn. Sp. Pl. 1,597. Marsupella polyanthos, Dumort. Comm. Bot., p. 114. W. On wet rocks, &c. D. Common.

Harpanthus. Nees.

scutatus, Spruce. Jungermannia scutata, Weber et Mohr. Deutschl. Crypt., p. 408. Jungermannia stipulacea. Hook. Brit. Jung., t. 41. W. Moist banks, and on rocks among the larger mosses, &c., at Upper Lough Bray.

Sub-Tribe 4.—Saccogyneæ, Dumortier.

Kantia. Bennett Gray.

trichomanis, Dicks, B. Gr. Jungermannia trichomanis. Hook. Brit. Jung., tab. 79. On wet, shady banks, and woods. W. D. Common.

arguta, N. M., Lindb. Calypogeia arguta, N. M., Lindb. Eng. Bot. tab., 1875. W. On wet banks, and on the larger Hepaticæ, at Luggelaw. Very rare.

Saccogyna. Dumortier.

viticulosa, Mich, Dumort. Jungermannia viticulosa, Linn. Sp. Pl. 1597. W. On damp ground, among mosses, &c. Very fine at Lough Bray. D. Killakee Glen.

Sub-Tribe 5.—Blepharozieæ.

Tricocholea. Dumortier.

tomentella, Ehrhart, Dumort. Jungermannia tomentella, Ehrh. Beitr. 2, p. 150. Hook. Brit. Jung., t. 36. W. Mossy banks in woods and rocky places. D. Common.

Herberta. Bennett Gray.

adunca, Dicks, B. Gr. Jungermannia adunca, Dicks. Fasc. Pl. Crypt. Brit. 3, p. 12, tab. 8, f. 8. Sendtnera juniperina, var. β, Nees, in G. L. et N. Synop. Hepat., p. 239. W. Bogs and wet rocky places, at Upper Lough Bray.

Blepharostoma. Dumortier.

trichophylla, Linn., Dumort. Jungermannia trichophylla, Linn. Sp. Pl., p 1601. Hook. Brit. Jung., t. 7. W. On turfy heaths, and among Sphagnum, at Lough Bray.

setacea, Web., Mitt. Jungermannia setacea, Weber, Spicil. Fl. Gott, p. 143. Hook. Brit. Jung., t. 8. W. Bogs, and moist shady banks in woods, &c., at Lough Bray.

SUB-TRIBE 6.—JUNGERMANNIEÆ.

Scapania. Dumortier.

subalpina, Dumortier. Var. β undulifolia. Jungermannia subalpina, Nees. apud Lindenb. Hep., p. 55. W. Margins of the mountain streams, where the water is constantly trickling over. Lugnaquilla .mountain, also at Lough Bray. D. At Kelly's Glen, in similar places.

undulata, Linn., Dill. Dumort, Jungermannia undulata, Linn, Sp. Pl., 1598. Hook. Brit. Jung., tab. 22. Radula undulata. Dumort. Comm. Bot., p. 112. W. Streams among the hills. D. Common.

var. ε. speciosa, Rabenhor. Hep. Eur., exsicc. n., 442. Was collected near Lugnaquilla. W.

irrigua, Nees. Dumort. Jungermannia irrigua, Nees Europ. Leber., 1, p. 193. W. Wet places among the hills, at Lough Bray.

resupinata, Dumort. Non : Hook. Jungermannia resupinata, Linn. Sp. Pl., 1599. Martinellia gracilis. Lindb. in Hort. Soc. T. Fl. Fenn. 13, p. 365 (1874.) Acta Societatis Scientiarum Fenicæ, X., p. 520 (1875.) W. Open heathy places, Lough Bray. D. Kelly's Glen.

umbrosa, Schrader. Dumort, Jungermannia umbrosa, Hooker. Brit. Jung., t. 24, suppl. 3. Engl. Bot., t. 2527. W. On moist rocks and banks, Lough Bray. D. Killakee Glen.

curta, Dumort. Jungermannia nemorosa. Var. δ. denudata, Hook., Brit. Jung., t. 21. Jung. curta, Mart. Fl. Crypt. Erlang., p. 148. Hab. W. Moist shady banks, among the larger Hepaticæ, at Upper Lough Bray.

Diplophyllum. Dumortier.

albicans, Linn. Dumort. Jungermannia albicans, Linn., Sp. Pl., p. 1599. Hook., Brit. Jung., t. 23. W, On moist banks, &c. D. Common.

Plagiochila. Dumortier.

asplenioides, Linn. Dumort. Jungermannia asplenioides, Linn., Sp. Pl., p. 1597. Eng. Bot., 1061. Hook. Brit. Jung., t. 13. Hab. W. Banks among moss, and in woods. D. Common.

spinulosa, Dicks. Dumort. Jungermannia spinulosa, Dicks. Crypt. fasc. 2, p. 14. Hook., Brit. Jung., t. 14. Eng. Bot., t. 2228. Tayl. Fl. Hib. 2, p. 58. Hab. W. Woods and moist banks. D. C.

Plagiochila. Dumortier.

punctata, Taylor. In London Journal of Bot. 1844, p. 371 (sub. n. 10) et 1846, p. 261. Plagiochila spinulosa, β punctata, Carring. Irish Crypt., p. 19, t. 2, fig. 3 (1863) et Brit. Hepat. part 3, p. 60. W. Shady woods, and damp banks, Altadore Glen, near Delgany. Also at Seven Churches.

Mylia. Bennett Gray.

Taylori, Hook., B. Gray. Jungermannia Taylori, Hook., Brit. Junger., t. 34. Eng. Bot., t. 2318. Coleochila Taylori. Dumort. Hepat. Europ., p. 107. W. On wet banks, Lough Bray.

Jungermannia. Linnæus.

§ *A.—Aplozia.*

crenulata, Smith (Dumort.) Jungermannia crenulata, Sm., Eng. Bot., t. 1463. Hook. Brit. Jung., t. 37. Aplozia crenulata, Dumort. Hepat. Europ., p. 57 (1874.) W. On moist clay banks. D. Common.

Var β gracillima. Jungermannia gracillima, Sm. Eng. Bot , t. 2238. Hook. Brit. Jung., at descript. n. 37. J. genthiana, Hueben. Hepat. Germ., p. 107. W. In similar places as that of the larger state of the plant, at Westaston.

pumila, With., Dumort. Jungermannia pumila, Wither. Bot. An., ed. 3, p. 866. Hook. Brit. Jung., t. 17. W. On rocks, by the margins of streams, at Lough Bray.

sphærocarpa, Hook, Dumort. Jungermannia sphærocarpa. Hook. Brit. Jung., t. 74. Aplozia sphærocarpa. Dumort. Hep. Eur., p. 61. W. On stones, by sides of rivulets, Upper Lough Bray. D. Kelly's Glen.

riparia, Taylor, Dumort. Jungermannia riparia. Tayl. in Trans. Bot. Soc. Edin., p. 43. Cooke's Brit. Jung., p. 9, fig. 69. W. Sides of streams and pools, Lough Bray, and near Wooden Bridge.

nana, Nees. Hep. Europ., 1 p. p. 317, 278 ; 2 p. 466 ; 3 p. 533 ; 4 p. 41. Jungermannia lurida. Dumort. Hepat. Europ., p. 60 (1874.) W. On wet banks, by the sides of streams, at Seven Churches. D. Kelly's Glen.

§ *B.—Sphenolobum.*

Dicksoni, Hook. Brit. Jung., t. 48. Eng. Bot., 2591. Diplophyllum Dicksoni. Dumort. Rev. Jung., p. 16, et Hepat. Europ., p. 49 (1875.) W. On rocks and moist banks, in subalpine parts, at Lough Bray. D. In similar places. Very rare. Dr. Taylor.

minuta, Crantz. Hist. Græn., p. 288. Hook. Brit. Jung., t. 44. Diplophyllum minutum. Dumort. Rev. Jung., p. 16, et Hepat. Europ., p. 49. W. Heathy and rocky banks, Lough Bray, and Seven Churches.

§ *C.—Lophozia, Dumortier.*

Hornschuchiana, Nees. Europ. Leberm. 2, p. 153. G. L. et N. Synop. Hepat., p. 101. W. Wet places, near Woodenbridge.

barbata, Schreber. Spicil. Lips., p. 107. J. quinquidentata, Huds. Angl. Fl., p. 511. Lophozia barbata. Dum. Rev. Jung., p. 17. W. Among rocks and on heathy banks. Frequent. D. In similar places. Frequent.

Lyoni, Taylor in Trans. Bot., Soc. Edinb., 1 p. 116, t. 7. J. Socia. var., G. γ., et N. Synop. Hepat, p. 112. I. barbata Var. G. L. et N., l. c. p. 678. W. On rocky banks among mosses, at Glenmalur. Rare.

ventricosa, Dicks. Pl. Crypt, 2, p. 14. Hook. Brit. Jung. t. 28. Eng. Bot. t. 2568. Tayl in Fl. Hib. 2, p. 60. W. Banks and rocks in mountain situations, Lough Bray, &c., frequent. D. In similar situations, frequent.

excisa, Dicks. Pl. Crypt. 3, p. 11, t. 8, fig. 7. Hook, Brit. Jung., p. 11. Lophozia excisa, Dumort. Rev. Jung., p. 17. Woods and heathy banks. D. On the mountains. (Taylor) Rare.

bicrenata, Lindenb. Synop. Hepat. p. 82. Jungermannia excisa Sm. Engl. Bot. t. 2497. W. On damp shady banks, Lough Bray.

§ *D.—Gymnocolea, Dumortier.*

laxifolia, Hook. Dumort Hook. Brit. Jung. t. 59. Eng. Bot. t. 2677. Gymnocolea laxifolia, Dumort. Rev. Jung. p. 17. et Hepat. Eur. p. 64. D. On rocks by the sides of rivulets, Castle Kelly Mountain, Dr. Taylor.

inflata, Huds. Dumort. Jungermannia inflata, Huds, Flor, Ang. p. 511. Gymnocolea inflata, Dumort, Rev. Jung. p. 17. et Hepat. Europ. p. 63. Hab. W. On wet rocks and banks, Lough Bray. D. Near Finglas.

var, *a* compacta, Carrington. D. On the top of Howth Hill.

affinis, Wilson. Dumort. Jungermannia turbinata. Wils. in Eng. Bot. suppl. t. 2744. J. Wilsoniana, Nees. Europ. Leberm. 3, p. 548. Cooke, Brit. Jung. p. 10. f. 74. D. On the grey limestone, Woodlands, near Clonsilla, and the Finglas quarries.

Nardia. Bennett Gray.

§ *A.—Marsupella (Dum) Lindberg.*

emarginata, Ehrh. B. Gr. Jungermannia emarginata, Ehrh. Beitr. 3, p. 80. Sm. Eng. Bot. t. 1022. Hook. Brit. Jung. t. 27. Sarcoscyphus Ehrharti. Corda in Opiz. Natural., p. 652. W. Wet rocks and sides of mountain rivulets. D. In similar situations. Common.

sphacelata, Giesecke. Jungermannia sphacelata, Giesecke in Lindenb. Synop. Hep. p. 76. Sarcoscyphus sphacelatus, Nees, Europ. Leber, p. 129. W. Wet rocks by the margins of the mountain rivulets at Upper Lough Bray. Very rare. S. O. Lindberg.

revoluta, Nees. Lindb. Sarcoscyphus revolutus. Nees Leberm, Eur. 2, p. 419. W. On rocks at Luggelaw. Very rare, D. Orr.

§ *B.—Mesophylla, Dumortier.*

scalaris, Schrader. B. Gr. Jungermannia scalaris, Schrad. Samml. 2, p. 4. Hook. Brit. Jung. t. 61. Alicularia scalaris corda, in Opiz. Natural, p. 653. W. On moist clay banks. D. Common.

compressa, B. Gr. Carrington. Jungermannia compressa. Hook. Brit. Jung. t. 58, Alicularia compressa, G. L. et N, Syn. Hepat. p. 12. W. Sides of rivulets and moist rocky places, at Upper Lough Bray; also at Luggelaw and Seven Churches. D. In similar places in Kelly's Glen.

Var β. rigida, Lindb. W. In wet boggy places at Upper Lough Bray and Seven Churches.

§ *C.—Southbya, Spruce.*

obovata, Nees. Carrington. Jungermannia obovata, Nees, Europ. Leberm. 1, p. 332; 2, p. 474. Cooke. Brit. Jung. p. 8, fig. 62. Jungermannia tersa. Nees. Europ. Leberm, p. 471. W. Moist rocks, and by the sides of rivulets at Upper Lough Bray.

hyalina, Lyell. Carrington. Jungermannia hyalina, Lyell, in Hook. Brit. Jung, t. 65. Cook, Brit. Jung. p. 8, fig. 61. W. Moist banks and damp rocky recesses at Luggelaw, and Seven Churches. D. In similar places on Seefing mountain. Dr. Taylor.

Sub-tribe 7.—Fossombroneæ.

Pallavicinia. Bennett Gray.

Hibernica, Hook. B. Gray. Jungermannia Hibernica Hook. Brit. Jung. t. 78. Blyttia Lyell, var γ. Hibernica. G. L. et N. Synop. Hep. p. 475. Moerckia Hibernica, Gottsche, in Rabenh. Hep. Europ. exsic. n. 295,334, et 335. D. On damp sandy ground, among the sand-hills near the sea where water has stood during the winter at the North Bull, and between Malahide and Portrane, very rare and local.

Lyellii, Hook. B. Gr. Jungermannia Lyellii, Hook. Brit. Jung. t. 77. Dilæna Lyellii Dumort. Comm. Bot. p. 114 (1822). Blyttia Lyellii, G. L. et N. Synop. Hep. p. 475. W. Boggy places among Sphagnum, at Upper Lough Bray.

Petalophyllum. Gottsche.

Ralfsii, Gottsche, Wilson. Jungermannia Ralfsii Wilson, in suppl. to Eng. Bot., t. 2,874. Petalophyllum lamellatum. Lindberg, Manipulus, Musc. Secund., p. 396. D. On damp sandy ground near the sea, Malahide sands, and at North Bull sands. Not hitherto observed elsewhere in Ireland.

Blasia. Micheli.

pusilla. Linn. Sp. Pl., 1,605. Jungermannia Blasia. Hook, Brit. Jung., t. 82–84. Tayl., in Fl. Hib., p. 56. W. On sandy moist banks, near Woodenbridge. D. Castle Kelly Glen fruiting in March.

Pellia. Raddi.

epiphylla, Dill. L. Raddi. Jungermannia epiphylla, Linn. Sp. Pl. 1, ed. 2, p. 1,135. Hook, Brit. Jung., t. 47, figs. 1, 4, 8, 1, 17. Tayl. in Fl. Hib., p. 56. W. On moist clay banks. D. In similar places. Common.

calycina, Nees. Tayl. Jungermannia epiphylla, Var γ. furcigera. Hook, Brit. Jung., t. 47, fig. 18, et. 2, 3, 9, 10–12. Jungermannia calycina. Tayl., in Fl. Hib., 2, p. 55. Pellia endivifolia, Pluk., Dicks. W. Shady moist places, sometimes quite immersed in water, at Altadore Glen, and Lough Bray.

Sub-tribe 8.—*Metzgerieæ.*

Metzgeria. Raddi.

furcata, Linn. Dumort. Jungermannia furcata, Linn. Sp. Pl., 1,602. Hook, Brit. Jung., t. 55, et. 56. Eng. Bot., t. 1,632. Metzgeria glabra, Raddi. Jung., Etr. in Mem. Modena.18, p. 43, t. 7, fig. 1. W. On trunks of trees, and also on moist banks and rocks. D. In similar situations. Common.

Var. δ. æruginosa. W. On trunks of trees, frequent. D. Frequent in similar situations.

Riccardia. Bennett Gray.

multifida, Dill., Linn., Gr. Jungermannia multifida, Linn, Sp. Pl., p. 1,602. Eng. Bot., t. 186. Hook, Brit. jung., t. 45. excl. Var. β. Aneura multifida, Dumort. Comm. Bot., p. 115. W. On wet places where water has stood during winter. D. In similar places. Common.

Var. pinnatifida Dumort, Syll. Jung.—Aneura pinnatifida, Dumort. Rev. Jung, p. 26, are found at Luggielaw and Lough Bray. W.

palmata, Hedw. Carruth., Lindb. Jungermannia palmata Hedw. Theor. Gen. 1 ed., p. 87, t. 18, figs. 93, 95; et tab. 19, figs. 96–98. Aneura palmata, Dumort. Comm. Bot., p. 115. W. On the decaying trunks of old trees at Altadore Glen, near Delgany.

pinguis, Linn., B. Gr. Jungermannia pinguis, Linn. Sp. Pl. p. 1,602. Hook, Brit. jung., t. 46. Eng. Bot., t. 185. Aneura pinguis, Dum. Comm. Bot., p. 115. Cooke, Brit. Jung., p. 23, fig. 174. W. Damp ravines, and margins of rivulets at Lough Bray. D. On wet sand at Malahide.

SECTION III.—ANTHOCEROTACEÆ.

Tribe 2.—*Anthoceroteæ.*

Anthoceros. Micheli.

punctatus, Linn. Sp. Pl. 1,606. Sm. Eng. Bot., t. 1,537. W. Wet places by the sides of streams. Sugar Loaf Mountain. D, At Kelly's Glen.

LIST OF DIATOMACEÆ FOUND IN THE COUNTIES OF DUBLIN AND WICKLOW.

BY

REV. EUGENE O'MEARA, A.M.

[Read March 18, 1878.]

Achanthes. Bory.	
,, longipes. Agardh,.	Sea-weeds near town of Wicklow.
,, brevipes. Agardh,	Malahide, Portmarnock, Salt Hill.
,, subsessilis. Kütz.	Malahide, co. Dublin.
,, exilis. Kütz.	Grand Canal, Hazlehatch, co. Dublin.
,, parvula. Kütz.	Clontarf, Portmarnock, co. Dublin.
Achnanthidium. Kütz.	
,, lanceolatum. Bréb.	Ditch near town of Wicklow.
,, coarctatum. Bréb.	Dollymount, co. Dublin.
,, microcephalum. Kütz,	Dundrum, co. Dublin.
,, lineare. Wm. Sm.,	Dundrum, co. Dublin.
Actinocyclus. Ehr.	
,, Ralfsii. Wm. Sm.,	Dalkey, co. Dublin.
,, moniliformis. Ralfs,	Ballybrack, co. Dublin.
,, crassus. Wm. Sm.,	Dalkey, Malahide, Howth, co. Dublin.
,, fulvus. Wm. Sm.,	Dalkey, co. Dublin.
Actinoptychus. Ehr.	
,, senarius. Ehr.	Dalkey, Dollymount, Portmarnock.
Amphipleura. Kütz.	
,, pellucida. Kütz.	Marl-pit near Arklow, co. Wicklow.
Amphiprora. Ehr.	
,, alata. Kütz.	Portmarnock, Malahide, co. Dublin. Seaweeds near Wicklow.
,, didyma. Wm. Sm.	Malahide, co. Dublin.
,, vitrea. Wm. Sm.	Howth, co. Dublin. Salt marsh near town of Wicklow.
,, constricta. Ehr.	Salt Hill, Malahide, co. Dublin.
,, duplex. Donkin,	Salt Hill, Howth, co. Dublin. Bray, co. Wicklow.
,, lepidoptera. Greg.	Malahide, Ireland's Eye, co. Dublin. Breaches, co. Wicklow.
,, maxima. Greg.	Malahide, co. Dublin.
,, pusilla. Greg.	Malahide, co. Dublin. Breaches, co. Wicklow.
Amphitetras. Ehr.	
,, antediluviana. Ehr.	Howth, Malahide, Rush, co. Dublin.

Amphora. Ehr.	
,, sulcata. Bréb. .	North Strand, co. Dublin.
,, ovalis. Kütz. .	Killakee, co. Dublin.
,, affinis. Kütz. .	Portmarnock, co. Dublin.
,, hyalina. Kütz. .	Malahide, co. Dublin.
,, salina. Wm. Sm. .	Dollymount, Malahide, co. Dublin. Kilcool, co. Wicklow.
,, membranacea. Wm. Sm.	Malahide, co. Dublin.
,, minutissima. Wm. Sm.	Killakee, Friarstown, Lucan, co. Dublin.
,, lævis. Greg. .	Howth, co. Dublin.
,, pellucida. Greg. .	Howth, co. Dublin.
,, robusta. Greg. .	Ireland's Eye, co. Dublin.
,, cymbifera. Greg. .	Ireland's Eye, co. Dublin. Kilcool, co. Wicklow.
,, crassa. Greg. .	Malahide, Ireland's Eye, co. Dublin.
,, dubia. Greg. .	Malahide, co. Dublin.
,, ventricosa. Greg. .	Salt ditch near town of Wicklow.
,, arenaria. Donkin, .	Malahide, co. Dublin.
,, granulata. Greg. .	Malahide, co. Dublin.
,, lævissima. Greg. .	Portmarnock, co. Dublin.
,, lyrata. Greg. .	Malahide, Baldoyle, co. Dublin.
,, nana. Greg. .	Malahide, Baldoyle, co. Dublin.
,, elongata. Greg. .	Malahide, co. Dublin.
,, ocellata. Donkin, .	Baldoyle, co. Dublin.
Arachnodiscus. Ehr.	
,, Ehrenbergii. Bailey, .	Malahide, co. Dublin.
Asterionella. Hassall.	
,, formosa. Hassall, .	R. Dodder. Grand Canal, co. Dublin.
,, Ralfsii. Wm. Sm. .	Tinahely, co. Wicklow.
,, gracillima. Heiberg, .	Dollymount, co. Dublin.
,, Bleakleyii. Wm. Sm.	Dalkey, Portmarnock, Howth, co. Dublin.
Auliscus. Ehr.	
,, sculptus. Wm. Sm. .	Malahide, Dollymount, co. Dublin.
Bacillaria. Gmel.	
,, paradoxa. Gmel. .	Clontarf, co. Dublin. Salt ditch near town of Wicklow.
Berkeleya. Greville, .	
,, fragilis. Greville, .	Salt Hill, co. Dublin.
Biddulphia. Gray,	
,, turgida. Ehr. .	Malahide, co. Dublin.
,, aurita. Lyngb. .	Ballybrack, Malahide, Dollymount, Howth, co. Dublin.
,, rhombus. Ehr. .	Malahide, Baldoyle, Ballybrack, Dollymount, co. Dublin.
,, pulchella. Gray, .	Malahide, Baldoyle, co. Dublin.
Campylodiscus. Ehr.	
,, costatus. Wm. Sm. .	R. Dodder, Bohernabreena, co. Dublin.

Campylodiscus. Ehr.		
,,	Hodgsonii. Wm. Sm. .	Malahide, co. Dublin. Bray, co. Wicklow.
,,	spiralis. Wm. Sm. .	Glencree. Bray, co. Wicklow.
,,	cribrosus. Wm. Sm. .	Dublin Bay. Breaches, co. Wicklow.
,,	parvulus. Wm. Sm. .	Malahide, Baldoyle, co. Dublin.
,,	Ralfsii. Wm. Sm. .	Malahide, Sutton, co. Dublin.
,,	simulans. Greg. .	Portmarnock, co. Dublin.
,,	bicostatus. Wm. Sm.	Portmarnock, co. Dublin.
Cocconeis. Ehr.		
,,	pediculus. Ehr. .	Everywhere in fresh water.
,,	Thwaitesii. Wm. Sm.	Blackcastle, co. Wicklow.
,,	scutellum. Ehr. .	Malahide, Portmarnock, co. Dublin. Sea-weeds near Wicklow.
,,	diaphana. Wm. Sm.	Dalkey, co. Dublin.
,,	arraniensis. Grev. .	Malahide, co. Dublin.
,,	lamprosticta. Greg. .	Malahide, Portmarnock, co. Dublin.
,,	Grantiana. Grev. .	Portmarnock, co. Dublin.
,,	granulifera. Grev. .	Portmarnock, co. Dublin.
,,	binotata. Grunow, .	Malahide, co. Dublin.
,,	punctatissima. Grev.	Stomachs of ascidians. Dublin Bay.
Cocconema. Ehr.		
,,	lanceolatum. Ehr. .	Newcastle Lyons, co. Dublin. Powerscourt, co. Wicklow.
,,	cymbiforme. Ehr. .	Clontarf, R. Dodder, Newcastle Lyons, co. Dublin.
,,	cistula. Ehr. .	Clontarf, Botanic Gardens, Glasnevin, co. Dublin.
,,	parvum. Wm. Sm. .	Portobello, Dundrum, co. Dublin. Slate quarry, Glenmore, co. Wicklow.
,,	cornutum. Ehr. .	Dundrum, co. Dublin.
Colletonema. Bréb.		
,,	vulgare. Thwaites .	Carrickmacrilly, co. Wicklow.
,,	neglectum. Thwaites.	Grand Canal, co. Dublin.
Coscinodiscus. Ehr.		
,,	oculus iridis. Ehr. .	Monkstown, Ballybrack, Dalkey, co. Dublin.
,,	omphalanthus. Ehr. .	Dublin Bay.
,,	centralis. Ehr. .	Ballybrack, Dalkey, co. Dublin.
,,	stellaris. Roper, .	Dublin Bay.
,,	concinnus. Wm. Sm.	Ballybrack. Dublin Bay.
,,	perforatus. Ehr. .	Oyster beds, Howth, Monkstown, Dalkey, Ballybrack, co. Dublin.
,,	radiatus. Ehr. .	Dollymount, Ballybrack, Malahide, Dalkey, co. Dublin.
,,	radiolatus. Ehr. .	Dalkey. Dublin Bay.
,,	nitidus. Greg. .	Malahide, co. Dublin.

Coscinodiscus. Ehr.	
„ lineatus. Ehr. .	Malahide, Monkstown, co. Dublin. Seaweeds, Wicklow. Breaches, co. Wicklow.
„ Ehrenbergii. O'M. .	Malahide, Dollymount, co. Dublin.
„ minor. Ehr. .	Tide-pool, Dalkey, co. Dublin.
„ punctulatus. Greg. .	On Fucus serratus, Ballybrack, co. Dublin.
„ eccentricus. Ehr. .	Dublin Bay.
Creswellia. Grev.	
„ turris. Grev. .	Dublin Bay.
Cyclotella. Kütz.	
„ Kützingiana. Thwaites.	R. Liffey, co. Dublin. Kilcool, co. Wicklow.
„ Meneghiniana. Kütz.	Feather-bed mountain, Lucan, co. Dublin. Kilcool, co. Wicklow.
„ operculata. Kütz. .	Glencree, co. Wicklow.
„ var. O'M. .	Ballymore Eustace, co. Wicklow.
„ rotula. Kütz. .	Lucan, Feather-bed mountain, Grand Canal, co. Dublin.
Cymatopleura. Wm. Sm.	
„ solea. Wm. Sm., .	Newcastle Lyons, co. Dublin ; Powerscourt, co. Wicklow.
„ apiculata. Wm. Sm.	Killakee, R. Dodder, co. Dublin ; Powerscourt, co. Wicklow.
„ parallela. Wm. Sm. .	R. Dodder, co. Dublin.
„ elliptica. Wm. Sm. .	Lucan, Grand Canal, Portobello, co. Dublin.
Cymbella. Agardh.	
„ cuspidata. Kütz. .	Bohernabreena, Dundrum, Howth, co. Dublin.
„ affinis. Kütz. .	Piperstown, co. Dublin.
„ maculata. Kütz. .	Newcastle Lyons, co. Dublin ; Kilcool, co. Wicklow.
„ helvetica. Kütz. .	Kilcool, co. Wicklow.
„ ventricosa. Agardh, .	Lucan, R. Dodder, co. Dublin.
„ lunata. Rab., .	Howth, co. Dublin.
„ porrecta. Rab., .	Howth, co. Dublin.
Denticula. Kütz.	
„ obtusa. Kütz. .	R. Dodder, Grand Canal, co. Dublin.
„ mutabilis. Wm. Sm .	Lucan, Bohernabreena, co. Dublin ; Black Castle, co. Wicklow.
„ ocellata. Wm. Sm. .	North Wall, co. Dublin.
Diatoma. De Candolle.	
„ vulgare. Bory, .	R. Dodder, Grand Canal, Portobello, co. Dublin.
„ grande. Wm. Sm. .	Killakee, R. Liffey, co. Dublin.

Diatoma. De Candolle.	
„ elongatum. Agardh .	Dundrum, co. Dublin; Newcastle, co. Wicklow.
„ tenue. Kütz. .	Howth, co. Dublin.
Dickieia. Berkeley.	
„ ulvoides. Berkeley, .	Greystones, co. Wicklow.
„ pinnata. Ralfs, .	Dollymount, Clontarf, Malahide, Ballybrack, co. Dublin.
Dimerogramma. Ralfs.	
„ minus. Greg. .	Dollymount, Ireland's Eye, co. Dublin.
Donkinia. Ralfs,	
„ carinata. Donkin, .	Malahide, co. Dublin.
„ recta. Donkin, .	Malahide, Ireland's Eye, co. Dublin.
„ angusta. Donkin, .	Howth, co. Dublin.
„ minuta. Donkin, .	Salthill, co. Dublin.
Encyonema. Kütz.	
„ prostratum. Ralfs, .	R. Dodder, co. Dublin.
„ cæspitosum. Kütz, .	Dundrum, R. Dodder, co. Dublin.
Epithemia. Kütz.	
„ turgida. Wm. Sm., .	Powerscourt, Glencree, Arklow, co. Wicklow.
„ granulata. Kütz. .	Powerscourt, co. Wicklow.
„ zebra. Kutz. .	Arklow, co. Wicklow.
„ longicornis. Ehr., .	Glencree, co. Wicklow.
„ alpestris. Wm. Sm .	R. Dodder, co. Dublin; Glencree, Newcastle, Co. Wicklow.
„ sorex. Kütz. .	Greystones, co. Wicklow.
„ musculus. Kütz. .	Malahide, Dollymount, co Dublin.
„ rupestris. Wm. Sm .	Killakee, R. Dodder, co. Dublin; Glencree, co. Wicklow.
„ constricta. Wm.Sm .	Portmarnock, co. Dublin; Kilcool, co. Wicklow.
„ gibba. Kütz. .	R. Dodder, co. Dublin; Powerscourt, co. Wicklow.
„ ventricosa. Kütz. .	Killakee, R. Dodder, co. Dublin.
„ marina. Donkin, .	Sea-weeds, near town of Wicklow.
„ globigera. Heiberg, .	Marl-pit, Arklow, co. Wicklow.
Eunotia. Ehr.	
„ arcus. Wm. Sm., .	R. Dodder, co. Dublin; Powerscourt, co. Wicklow.
„ gracilis. Wm. Sm., .	Piperstown, co. Dublin; Rathdrum, Powerscourt, co. Wicklow.
„ diodon. Ehr. .	Killakee, co. Dublin.
„ tetraodon. Ehr., .	Killakee, Feather Bed Mountain, co. Dublin.
„ camelus. Ehr., .	Feather Bed Mountain, co. Dublin.
Eupodiscus. Ehr.	
„ argus. Ehr., .	Dublin Bay.

Fragillaria. Lyng.	
,, capucina. Desmar. .	Everywhere in fresh water.
,, virescens. Ralfs, .	Friarstown, Piperstown, Killakee, co. Dublin; Glencree, Greenane, co. Wicklow.
,, æqualis. Heiberg, .	Oyster Beds, Malahide, Co. Dublin.
,, maxima. O'Meara, .	Aghold, co. Wicklow.
,, crotonensis. Kitton .	Newcastle Lyons, co. Dublin; Greenane, co. Wicklow.
,, tenuicollis. Heiberg .	Malahide, co. Dublin; Greenane, co. Wicklow.
,, striatula. Lyng. .	Ballybrack, Monkstown, Kingstown, co. Dublin; Arklow, co. Wicklow.
,, construens. Ehr., .	Piperstown, Killakee, co. Dublin.
,, undata. Wm. Sm., .	Bohernabreena, Killakee, co. Dublin.
,, mesolepta. Rab., .	Malahide, Ringsend, co. Dublin.
Gomphonema. Agardh.	
,, geminatum. Agardh.	R. Dodder, Bohernabreena, co. Dublin.
,, constrictum. Ehr., .	Lucan, Friarstown, Malahide, co. Dublin; Arklow, co. Wicklow.
,, acuminatum. Ehr., .	Friarstown, R. Dodder, co. Dublin; Powerscourt, Arklow, co. Wicklow.
,, dichotomum. Kütz. .	Powerscourt, co. Wicklow.
,, tenellum. Wm. Sm. .	Lucan, Malahide, co. Dublin; Arklow, co. Wicklow.
,, capitatum. Ehr., .	Newcastle Lyons, co. Dublin.
,, olivaceum. Ehr., .	Very common.
,, intricatum. Kutz, .	Powerscourt, Arklow, co. Wicklow.
,, vibrio. Ehr., .	Malahide, co. Dublin; Arklow, co. Wicklow.
,, elongatum. Wm. Sm.	Arklow, co. Wicklow.
,, insigne. Greg. .	Friarstown, Boat Harbour, Dolphin's Barn, co. Dublin; Powerscourt, Glencree, co. Wicklow.
,, hebridense. Greg. .	Killakee, co. Dublin.
,, rostratum. Wm. Sm.	Pond in Trinity College Botanic Gardens, co. Dublin; Arklow, co. Wicklow.
,, minutissimum. Greg. .	Friarstown. R. Dodder, co. Dublin.
,, sarcophagus. Greg. .	R. Dodder, co. Dublin.
Himantidium. Ehr.	
,, pectinale. Kutz. .	Carrickmacrilly, Powerscourt, co. Wicklow.
,, undulatum. Wm. Sm.	Rathdrum, Powerscourt, co. Wicklow.
,, Soleirolii. Kütz. .	Piperstown, Feather Bed Mountain, R. Dodder, co. Dublin; Powerscourt, co. Wicklow.
,, arcus. Wm. Sm., .	Glencree, Powerscourt. Rathdrum, co. Wicklow.

Himantidium. Ehr.	
„ bidens. Ehr., .	Killakee, co. Dublin.
„ gracile. Ehr., .	Powerscourt, co. Wicklow.
„ majus. Wm. Sm. .	Rathdrum, Lugnaquilla, co. Wicklow.
„ nodosum. Ehr., .	Powerscourt, co. Wicklow.
Homeocladia. Agardh.	
„ Martiana. Agardh, .	Monkstown, co. Dublin.
„ filiformis. Wm. Sm .	Howth, co. Dublin.
„ sigmoidea. Wm. Sm .	North Wall, co. Dublin.
Isthmia. Agardh.	
„ nervosa. Kütz, .	Malahide, co. Dublin.
„ enervis. Ehr., .	Malahide, co. Dublin.
Lichmophora. Agardh.	
„ flabellata. Agardh, .	Malahide, Howth, co. Dublin.
„ splendida. Grev. .	Sutton, Ballybrack, co. Dublin.
Lysigonium. Link.	
„ nummuloides. Wm. Sm.	Malahide, Dollymount, co. Dublin; Salt Ditch near Wicklow.
„ Westii. Wm. Sm., .	Dollymount, Oyster Beds, Howth, co. Dublin; Salt ditch near Wicklow.
Mastogloia. Thwaites & Wm. Sm.	
„ lanceolata. Thwaites.	Dollymount, co. Dublin; Kilcool, co. Wicklow.
„ Danseii. Thwaites, .	Kilcool, co. Wicklow.
„ apiculata. Wm. Sm.	Dollymount, co. Dublin.
„ Smithii. Thwaites, .	Kilcool, Greystones, co. Wicklow.
„ Grevillii. Wm. Sm. .	Kilcool, co. Wicklow.
Melosira. Agardh.	
„ Borreri. Greville, .	Malahide, Dollymount, Howth, co. Dublin; Salt ditch near Wicklow.
„ subflexilis. Kütz, .	Greystones, co. Wicklow.
„ varians. Agardh, .	Common in fresh water.
„ distans. Kütz. .	Killakee, Dundrum, co. Dublin; Kilcool, co. Wicklow.
Meridion. Agardh.	
„ circulare. Agardh, .	Friarstown, Killiney, co. Dublin; Glencree, co. Wicklow.
Navicula. Bory.	
„ nobilis. Ehr., .	Feather Bed Mountain, co. Dublin; Lugnaquilla, co. Wicklow.
„ major. Kütz. .	Killakee, Feather Bed Mountain, co. Dublin; Arklow, Greenane, co. Wicklow.
„ viridis. Nitzsch, .	Friarstown, Feather Bed Mountain, co. Dublin; Greenane, Lugnaquilla, co. Wicklow.

Navicula. Bory.	
„ alpina. Wm. Sm., .	Killakee, Feather Bed Mountain, co. Dublin.
„ pachyptera. Ehr., .	R. Dodder, Feather Bed Mountain, co. Dublin; Glencree, co. Wicklow.
„ distans. Wm. Sm., .	Malahide, Dalkey, Howth, Dollymount, co. Dublin.
„ Trevelyana. Donkin, .	Malahide, co. Dublin.
„ oblonga. Kütz. .	Newcastle Lyons, co. Dublin; Kilcool, Powerscourt, co. Wicklow.
„ divergens. Wm. Sm.,	Featherbed Mountain, Killakee, co. Dublin.
„ borealis. Ehr., .	Featherbed Mountain, co. Dublin; Glencree, co. Wicklow.
„ tabellaria. Ehr., .	Friarstown, Piperstown, Killakee, co. Dublin; Glencree, Lugnaquilla, co. Wicklow.
„ var. acrosphæria. Bréb,	Carnew, Greenane, co. Wicklow.
„ clepsydra. Donkin, .	Ireland's Eye, co. Dublin.
„ gibba. Ehr., .	Featherbed Mountain, co. Dublin; Rathdrum, Carrickmacrilly, Lugnaquilla, co. Wicklow.
„ hemiptera. Kütz. .	Lucan, Featherbed Mountain, Friarstown, co. Dublin; Rathdrum, co. Wicklow.
„ apiculata. Bréb. .	Malahide, Ireland's Eye, co. Dublin.
„ Brebissonii. Kütz. .	Featherbed Mountain, Killakee, co. Dublin; Rathdrum, co. Wicklow.
„ icostauron. Ehr., .	Featherbed Mountain, co. Dublin.
„ isocephala. Ehr., .	Friarstown, co. Dublin.
„ nodosa. Ehr., .	Friarstown, Featherbed Mountain, co. Dublin; Kilcool, Lugnaquilla, co. Wicklow.
„ bicapitata. O'Meara,	Kilcool, co. Wicklow.
„ var. crucifera. Pinnularia interrupta. Wm. Sm., .	Glencree, co. Wicklow.
„ var constricta. Grunow,	Featherbed Mountain, co. Dublin.
„ termes. Ehr., .	Featherbed Mountain, co. Dublin.
„ microstauron. Ehr.,	Featherbed Mountain, co. Dublin.
„ pinnularia. Cleve., .	Portmarnock, co. Dublin.
„ cuneata. O'Meara, .	Featherbed Mountain, co. Dublin.
„ acuminata. Wm. Sm.	Featherbed Mountain, Killakee, co. Dublin; Kilcool, co. Wicklow.
„ retusa. Bréb., .	Malahide, co. Dublin.
„ integra. Wm. Sm., .	Powerscourt, co. Wicklow.
„ pachycephala. Rab., .	Featherbed Mountain, Ballybrack, co. Dublin.
„ subcapitata. Greg. .	Friarstown, Featherbed Mountain, Killakee, co. Dublin.

Navicula. Bory.	
„ gracillima. Greg. .	Friarstown, Piperstown, co. Dublin; Rathdrum, Lugnaquilla, co. Wicklow.
„ cuspidata. Wm. Sm.,	River Dodder, co. Dublin; Powerscourt, co. Wicklow.
„ rhombica. Greg. .	Malahide, co. Dublin; Newcastle, co. Wicklow.
„ tumens. Wm. Sm. .	Salt Hill, co. Dublin; Newcastle, co. Wicklow.
„ rostrata. Ehr., .	Salt Hill, co. Dublin; Newcastle, co. Wicklow.
„ ovulum. Grunow, .	Malahide, co. Dublin.
„ latiuscula. Kütz. .	Newcastle, co. Wicklow.
„ Barkeriana. O'Meara,	Dalkey, co. Dublin; Newcastle, co. Wicklow.
„ amphisbæna. Bory. .	River Dodder, Dundrum, Blackrock, Malahide, co. Dublin; Newcastle, co. Wicklow.
„ subsalina. Ehr. .	Malahide, co. Dublin; Newcastle, co. Wicklow.
„ elegans. Wm. Sm. .	Blackrock, co. Dublin; Newcastle, co. Wicklow.
„ angulosa. Greg. .	Malahide, co. Dublin; Newcastle, co. Wicklow.
„ semiplena. Greg. .	Malahide, co. Dublin.
„ liber. Wm. Sm. .	Dollymount, co. Dublin; Newcastle, co. Wicklow.
„ iridis. Ehr. .	Kilcool, Glenmalure, co. Wicklow.
„ var. amphigomphus . Ehr. .	Piperstown, co. Dublin; Kilcool, co. Wicklow.
„ var. affinis. Ehr. .	Killakee, co. Dublin; Newcastle, Kilcool, Lugnaquilla, co. Wicklow.
„ dubia. Ehr. .	Pond, Trinity College Botanic Garden, co. Dublin; Kilcool, co. Wicklow.
„ limosa. Kütz. .	Pond, Trinity College Botanic Garden, co. Dublin; Powerscourt, co. Wicklow.
„ var. gibberula. Kütz.	Powerscourt, co. Wicklow.
„ var. truncata. Kutz.	Friarstown, River Dodder, co. Dublin.
„ producta. Wm. Sm. .	Pond, Trinity College Botanic Garden, co. Dublin.
„ maxima. Greg. .	Portmarnock, Ireland's Eye, co. Dublin; Newcastle, co. Wicklow.
„ subula. Kütz, .	Malahide, co. Dublin.
„ veneta. Kutz. .	Dollymount, co. Dublin; Bray River, co. Wicklow.
„ Johnsonii. Wm. Sm.	Malahide, Portmarnock, co. Dublin.
„ simulans. Donkin, .	Malahide, co. Dublin.

Navicula. Bory.

„ delginensis. O'Meara,	Dalkey Island, Malahide, co. Dublin.
„ rhomboides. Ehr. .	Friarstown, Piperstown, co. Dublin Rathdrum, Glencree, co. Wicklow.
„ serians. Bréb, .	Piperstown, co. Dublin; Glencree, co. Wicklow.
„ crassinervia. Bréb, .	Friarstown, Piperstown, Featherbed Mountain, co. Dublin; Rathdrum, Glencree, co. Wicklow.
„ dirhynchus. Ehr. .	Featherbed Mountain, co. Dublin.
„ rostellum. Wm. Sm.	Killakee, co. Dublin.
„ lævissima. Kütz. .	Pond, Trinity College Botanic Garden, co. Dublin.
„ oblongella. Naegelli,	Killakee, co. Dublin.
„ incurva. Greg. .	Portmarnock, co. Dublin.
„ punctulata. Wm. Sm.	Portmarnock, co. Dublin.
„ humerosa. Bréb, .	Portmarnock, Malahide, co. Dublin; Kilcool, co. Wicklow.
„ maculosa. Donkin, .	Dollymount, co. Dublin.
„ pusilla. Wm. Sm. .	Newcastle, co. Wicklow.
„ var. lanceolata. Grunow	Portmarnock, co. Dublin; Newcastle, co. Wicklow.
„ tumida. Wm. Sm. .	Kilcool, Powerscourt, co. Wicklow.
„ Smithii. Bréb. .	Kilcool, co. Wicklow.
„ Collisiana. O'Meara, .	Kilcool, co. Wicklow.
„ elliptica. Kütz. .	Lucan, Killakee, Bohernabreena, co. Dublin; Glencree, Powerscourt, co. Wicklow.
„ var. costata. O'Meara,	Newcastle, co. Wicklow.
„ lyra. Ehr. .	Malahide, Portmarnock, co. Dublin; Kilcool, co. Wicklow.
„ var. forcipata. Greville.	Malahide, Portmarnock, Dollymount, Dalkey, co. Dublin.
„ pygmæa. Kütz. .	Malahide, Portmarnock, Dollymount, co. Dublin.
„ musca. Greg. .	Dollymount, co. Dublin.
„ bombus. do. .	Malahide, Portmarnock, co. Dublin.
„ didyma. Ehr. .	Malahide, Portmarnock, Dollymount, co. Dublin.
„ apis. Kütz. .	Malahide, co. Dublin.
„ directa. Wm. Sm. .	Malahide, co. Dublin.
„ lanceolata. Kütz. .	Kilcool, co. Wicklow.
„ radiosa. do. .	River Dodder, Bohernabreena, Glennasmole, Killakee, co. Dublin.
„ gracilis. Ehr. .	Killiney, Ballybrack, co. Dublin.
„ acuta. Wm. Sm. .	River Dodder, pond, Trinity College Botanic Garden, co. Dublin; Kilcool, co. Wicklow.
„ peregrina. Ehr. .	Howth, co. Dublin; Newcastle, co. Wicklow.

Navicula. Bory.		
,,	digito-radiata. Greg. .	Kilcool, co. Wicklow.
,,	Ergadensis. Greg. .	Portmarnock, Malahide, co. Dublin.
,,	cyprinus. Ehr. .	Malahide, Portmarnock, Dalkey, co. Dublin ; sea-weeds near Wicklow town.
,,	solaris. Greg. .	Malahide, co. Dublin.
,,	veneta. Kütz. .	Killakee, Clontarf, co. Dublin.
,,	Heufleri. Grunow, .	Powerscourt, co. Wicklow.
,,	fortis. Greg. .	Malahide, co. Dublin.
,,	arenaria. Donkin, .	Portmarnock, co. Dublin.
,,	inflexa. Greg. .	Malahide, co. Dublin.
,,	carassius. Ehr. .	Dundrum, co. Dublin ; Glencree, Kilcool, co. Wicklow.
,,	mutica. Kütz. .	Killakee, co. Dublin ; Glencree, co. Wicklow.
,,	inflata. do. .	River Dodder, Killakee, co. Dublin ; Glencree, Kilcool, co. Wicklow.
,,	mesolepta. Ehr. .	Common in elevated districts.
,,	anglica. Ralfs. .	Killakee, pond, Trinity College Botanic Garden, co. Dublin.
,,	var. sublinearis. Donk.	Killakee, co. Dublin.
,,	angustata. Wm. Sm.	Malahide, co. Dublin ; Black Castle, co. Wicklow.
,,	binodis. Ehr. .	Powerscourt, co. Wicklow.
,,	dicephala. do. .	Friarstown, Lucan, Killakee, co. Dublin ; Powerscourt, co. Wicklow.
,,	rhynchocephala. Kütz.	River Dodder, Dundrum, co. Dublin ; Kilcool, co. Wicklow.
,,	rostellifera. Greg. .	Portmarnock, co. Dublin.
,,	cancellata. Donkin. .	Malahide, Potmarnock, co. Dublin.
,,	minor. Greg. .	Dollymount, co. Dublin.
,,	incurvata. Greg. .	Dollymount, co. Dublin.
Nitzschia. Hassall.		
,,	sigmoidea. Wm. Sm. .	Lucan, Newcastle Lyons, Dundrum, co. Dublin.
,,	Brebissonii. Wm. Sm.	Friarstown, R. Dodder, Bohernabreena, co. Dublin.
,,	sigma. Wm. Sm. .	Malahide, Portmarnock, co. Dublin ; Kilcool, co. Wicklow.
,,	linearis. Wm. Sm. .	Friarstown, R. Dodder, co. Dublin ; Powerscourt, co. Wicklow.
,,	spathulata. Wm. Sm.	Malahide, co. Dublin.
,,	angularis. Wm. Sm. .	Malahide, co. Dublin.
,,	lanceolata. Wm. Sm.	Salt Hill, co. Dublin.
,,	amphioxus. Wm, Sm.	Lucan, R. Dodder, Dundrum, co. Dublin ; Kilcool, co. Wicklow.
,,	vivax. Wm. Sm. .	Glenmalure, co. Wicklow.
,,	dubia. Wm. Sm. .	Malahide, Salt Hill, co. Dublin.

Nitzschia. Hassall.	
,, bilobata. Wm. Sm. .	Newcastle, co. Wicklow.
,, plana. Wm. Sm. .	Newcastle, co. Wicklow.
,, birostrata. Wm. Sm. .	Salt Hill, co. Dublin.
,, closterium. Wm. Sm. .	Salt Hill, co. Dublin.
,, curvula. Wm. Sm. .	Lucan, R. Dodder, co. Dublin.
,, panduriformis. Greg.	Portmarnock, salt ditch near town of Wicklow.
,, virgata. Roper, .	Malahide, Portmarnock, co. Dublin.
,, hyalina. Greg. .	Malahide, co. Dublin.
,, palea. Wm. Sm. .	Kilcool, co. Wicklow.
,, insignis. Greg. .	Dalkey, co. Dublin; Newcastle, co. Wicklow.
,, thermalis. Grunow, .	Killakee, Blackrock, co. Dublin; Kilcool, Powerscourt, co. Wicklow.
,, Hungarica. Grunow,	Kingstown, co. Dublin.
,, minutissima. Wm. Sm.	North Wall, co. Dublin.
Odontidium. Kütz. .	
,, sinuatum. Wm. Sm.	R. Dodder, co. Dublin; Slate Quarry, Glenmore, co. Wicklow.
,, hyemale. Lyngb. .	Black Castle, co. Wicklow.
,, mesodon. Ehr. .	Friarstown, Piperstown, co. Dublin; Glencree, Powerscourt, co. Wicklow.
,, anomalum. Wm. Sm.	Newcastle, co. Wicklow.
,, tenue. Kütz. .	Powerscourt, co. Wicklow.
,, elegans. Kütz. .	Powerscourt, Rathdrum, Black Castle, co. Wicklow.
Odontodiscus. Ehr. .	
,, excentricus. Ehr. .	Dollymount, Malahide, Dalkey, Ballybrack, co. Dublin.
Orthosira. Thwaites. .	
,, arenaria. D. Moore,	Killakee, co. Dublin; Kilcool, co. Wicklow.
,, sulcata. Ehr. .	Malahide, Dalkey, co. Dublin; near town of Wicklow.
,, orichalcea. Wm. Sm.	Killakee, co. Dublin; Glencree, co. Wicklow.
,, roseana. Rab. .	Killakee, co. Dublin.
Plagiogramma. Greville, .	
,, staurophorum. Greg.	Dollymount Oyster Beds, Malahide, co. Dublin.
Pleurosigma. Wm. Sm. .	
,, formosum. Wm. Sm.	Howth, Malahide, co. Dublin.
,, decorum. Wm. Sm.	Salt Hill, co. Dublin.
,, speciosum. Wm. Sm.	Salt Hill, co. Dublin.
,, elongatum. Wm. Sm.	Bray, Newcastle, co. Wicklow.
,, nubecula. Wm. Sm.	Malahide, co. Dublin; Kilcool, co. Wicklow.

Pleurosigma. Wm. Sm.	
„ delicatulum. Wm. Sm.	Malahide, co. Dublin; Salt Marsh, near town of Wicklow.
„ strigosum. Wm. Sm.	Dalkey, Howth, Malahide, co. Dublin.
„ quadratum. Wm. Sm.	Portmarnock, Malahide, co. Dublin; Salt Marsh, near town of Wicklow.
„ angulatum. Wm. Sm.	Malahide, co. Dublin; Salt Marsh, near town of Wicklow.
„ æstuarii. Wm. Sm. .	Malahide, co. Dublin.
„ balticum. Wm. Sm.	Dalkey, Portmarnock, co. Dublin; Salt Marsh, near town of Wicklow.
„ acuminatum. Wm. Sm.	Salt Hill, Portmarnock, co. Dublin.
„ distortum. Wm. Sm.	Portmarnock, Malahide, co. Dublin.
„ fasciola. Wm. Sm. .	Malahide, co. Dublin; Salt Marsh near town of Wicklow.
„ macrum. Wm. Sm. .	Ireland's Eye, co. Dublin.
„ prolongatum. Wm. Sm.	Malahide, co. Dublin; Salt Marsh, near town of Wicklow.
„ tenuissimum. Wm. Sm.	Malahide, co. Dublin.
„ littorale. Wm. Sm. .	Salt Marsh, near town of Wicklow.
„ hippocampus. Wm. Sm.	Portmarnock, co. Dublin; Newcastle, co. Wicklow.
„ attenuatum. Wm. Sm.	Grand Canal Portobello, Bohernabreena, co. Dublin; Kilcool, co. Wicklow.
„ lacustre. Wm. Sm. .	Grand Canal, Ditch, Phœnix Park, co. Dublin.
„ Spencerii. Wm. Sm.	Lucan, R. Dodder, Dundrum, co. Dublin; Dunlavin, co. Wicklow.
„ marinum. Donkin, .	Malahide, Kingstown, co. Dublin.
„ lanceolatum. Donkin.	Malahide, co. Dublin.
„ Wansbeckii. Donkin.	Newcastle, co. Wicklow.
„ Normanii. Ralfs. .	Dalkey, co. Dublin.
„ naviculaceum. Bréb.	Dublin Bay.
„ intermedium. Wm. Sm.	Portmarnock, co. Dublin.
Podocystis. Kütz.	
„ adriatica. Kütz. .	Dalkey, Sutton, co. Dublin.
Podosira. Ehr.	
„ maculata. Wm. Sm.	R. Liffey, Dublin.
Podosphenia. Ehr.	
„ Ehrenbergii. Kütz. .	Portmarnock, co. Dublin.
„ Lyngbyei. Kütz. .	Malahide, co. Dublin.
„ Jurgensii. Kütz. .	Malahide, co. Dublin.
Ralfsia. O'Meara.	
„ hyalina. Kütz. .	Newcastle, co. Wicklow.

Rhaphoneis. Ehr.	
,, rhombus. Ehr. .	Dollymount, co. Dublin.
,, Lorenziana. Grunow.	Dollymount, co. Dublin.
,, Harrisonii. Wm. Sm.	Friarstown, R. Dodder, Bohernabreena co. Dublin.
Rhabdonema. Kütz.	
,, arcuatum. Lyngb. .	Malahide, Ballybrack, co. Dublin.
,, minutum. Kutz. .	Malahide, Ballybrack, Salt Hill, Dollymount, co. Dublin.
,, adriaticum. Kütz. .	Malahide, co. Dublin.
Rhipidophora. Kütz.	
,, elongata. Kütz. .	Malahide, co. Dublin.
,, paradoxā. Kütz. .	Ballybrack, co. Dublin.
Rhizosolenia. Ehr.	
,, styliformis. Brightwell	Dalkey, co. Dublin.
,, setigera. Brightwell.	Dalkey, co. Dublin.
,, calcar-avis. Schultze.	Malahide, co. Dublin.
Rhoicosphenia. Grunow.	
,, curvata. Kütz. .	R. Dodder, co. Dublin.
,, marina. Wm. Sm. .	Kingstown, Malahide, co. Dublin.
Sceptroneis. Ehr.	
,, caduceus. Ehr. .	Monkstown, co. Dublin.
Schizonema. Agardh.	
,, crucigerum. Wm. Sm.	Malahide, Portmarnock, Salt Hill, co. Dublin.
,, Smithii. Agardh. .	Howth, Salt Hill, Malahide, co. Dublin.
,, divergens. Wm. Sm.	Malahide, Salt Hill, co. Dublin.
,, mucosum. Kütz. .	Malahide, Howth, co. Dublin.
,, Grevillii. Agardh. .	Malahide, Merrion, co. Dublin.
,, helmintosum. Chauvin	Howth, Malahide, co. Dublin.
,, comoides. Agardh. .	Howth, Malahide, co. Dublin.
,, parasiticum. Harvey.	Malahide, Salt Hill, co. Dublin.
,, obtusum. Grev. .	Merrion, Malahide, co. Dublin.
,, Dillwynii. Agardh. .	Merrion, co. Dublin.
Scoliopleura. Grunow. .	
,, Jennerii. Wm. Sm. .	Portmarnock, Malahide, co. Dublin.
,, Westii. Wm. Sm. .	Portmarnock, Malahide, co. Dublin.
,, convexa. Wm. Sm.	Portmarnock, Malahide, co. Dublin.
Striatella. Agardh. .	
,, unipunctata. Lyngb.	Howth, Salt Hill, co. Dublin; Bray, co. Wicklow.
Stauroneis. Ehr.	
,, Phœnicenteron. Ehr.	Killakee, co. Dublin; Kilcool, Glenmalure, co. Wicklow.
,, gracilis. Ehr. .	Friarstown, Killakee, co. Dublin; Powerscourt, co. Wicklow.

Stauroneis. Ehr.	
,, salina. Wm. Sm.	Newcastle, co. Wicklow.
,, crucicula. Wm. Sm.	Newcastle, co. Wicklow.
,, anceps. Ehr.	Friarstown, Lucan, Killakee, co. Dublin.
,, linearis. Ehr.	Lucan, Blackrock, co. Dublin; Glencree, co. Wicklow.
,, aspera. Kütz.	Portmarnock, Malahide, Dalkey, co. Dublin.
,, amphicephala. Kütz.	Killakee, co. Dublin. Glenchree, co. Wicklow.
,, amphioxus. Greg.	Malahide, co. Dublin.
,, exilis. Kütz.	Killakee, co. Dublin.
,, Mackintoshii. O'Meara	Stomachs of ascidians. Monkstown, co. Dublin.
Surirella. Turpin.	
,, biseriata. Bréb.	Feather-bed mountain, co. Dublin. Powerscourt, co. Wicklow.
,, linearis. Wm. Sm.	Killakee, co. Dublin. Rathdrum, Lugnaquilla, co. Wicklow.
,, constricta. Wm. Sm.	Newcastle, co. Wicklow.
,, splendida. Kütz.	Featherbed mountain, co. Dublin.
,, nobilis. Wm. Sm.	Featherbed mountain, co. Dublin.
,, striatula. Turpin,	Malahide, co. Dublin. Bray, co. Wicklow.
,, gemma. Ehr.	Howth, Portmarnock, Dollymount, co. Dublin. Bray, co. Wicklow.
,, fastuosa. Ehr.	Howth, Dalkey, Malahide, co. Dublin. Kilcool, co. Wicklow.
,, craticula. Ehr.	Marsh near town of Wicklow.
,, ovalis. Bréb	Portmarnock, co. Dublin.
,, panduriformis. Wm. Sm.	R. Dodder, co. Dublin.
,, Brightwellii. Wm. Sm.	Newcastle, co. Wicklow.
,, ovata. Kütz.	Lucan, co. Dublin.
,, salina. Wm. Sm.	Malahide, Clontarf, co. Dublin.
,, angusta. Kütz.	R. Dodder, Dundrum, co. Dublin. Powerscourt, co. Wicklow.
,, minuta. Bréb.	Friarstown, R. Dodder, Dundrum, co. Dublin. Blackcastle, Powerscourt, co. Wicklow.
,, elegans. Ehr.	Killakee, co. Dublin.
,, crumena. Bréb.	Newcastle, co. Wicklow.
,, apiculata. Wm. Sm.	Killakee, co. Dublin. Powerscourt, co. Wicklow.
Syndendrium. Ehr.	
,, diadema. Ehr.	Kingstown, co. Dublin.

Synedra. Ehr.

„ crystallina. Lyngb. .	Salt Hill, co. Dublin.
„ fulgens. Grev. .	Malahide, Dublin Bay.
„ superba. Kütz. .	Malahide, co. Dublin.
„ amphicephala. Kütz. .	Kilcool, Powerscourt, co. Wicklow.
„ investiens. Wm. Sm.	Malahide, Kingstown Harbour, Salt Hill, co. Dublin.
„ acuta. Kütz. .	Friarstown, Malahide, St. Fenton's Well, Sutton, co. Dublin.
„ tenuissima. Kütz. .	Bohernabreena, Dundrum, St. Fenton's Well, Sutton, co. Dublin.
„ gracilis. Kütz. .	Salt Hill, co. Dublin.
„ lunaris. Ehr. .	Lucan, co. Dublin. Glencree, Glenmalure, co. Wicklow.
„ biceps. Kütz. .	Killakee, co. Dublin. Carrickmacreilly, co. Wicklow.
„ pulchella. Kütz. .	Kilcool, co. Wicklow.
„ var. gracilis. Wm. Sm.	Blackcastle, Newcastle, co. Wicklow.
„ var. acicularis. Wm. Sm.	Kilcool, Blackcastle, co. Wicklow.
„ var. lanceolata. Wm. Sm.	Howth, co. Dublin. Kilcool, Blackcastle, co. Wicklow.
„ var. linearis. Wm. Sm.	Malahide, co. Dublin. Blackcastle, co. Wicklow.
„ capitata. Ehr. .	Lucan, Dundrum, co. Dublin. Kilcool, co. Wicklow.
„ ulna Ehr. .	R. Dodder, co. Dublin. Ditch near town of Wicklow.
„ var. oxyrhynchus. Kütz	R. Dodder, co. Dublin.
„ var. amphirhynchus. Ehr. .	Bohernabreena, R. Dodder, co. Dublin. Greenane, Powerscourt, co. Wicklow.
„ longissima. Wm. Sm.	Malahide, St. Fenton's Well, Sutton, co. Dublin. Ditch near town of Wicklow.
„ splendens. Kütz. .	Lucan, Friarstown, Bohernabreena, Malahide, co. Dublin.
„ var. radians. Kütz. .	Friarstown, co. Dublin.
„ salina. Wm. Sm. .	Malahide, Clontarf, co. Dublin.
„ Gallionii. Ehr. .	Malahide, Howth, co. Dublin.
„ spathulata. O'Meara.	Well, Newcastle Lyons, co. Dublin.
„ barbatula. Kütz. .	Salt Hill, co. Dublin.
„ tubulata. Agardh. .	Malahide, co. Dublin. Newcastle, co. Wicklow.
„ arcus. Kütz. .	Malahide, Monkstown, co. Dublin. Bray, co. Wicklow.
„ affinis. Kütz. .	Malahide, Clontarf, co. Dublin.
„ Nitzschoides. Grunow.	Rush, co. Dublin.
„ putealis. O'Meara, .	St. Fenton's Well, Sutton, co. Dublin
„ Smithii. O'Meara, .	St. Fenton's Well, Sutton, co. Dublin.

Tabellaria. Ehr.	
,, flocculosa. Roth.	Abundant in fresh water.
,, fenestrata. Lyngb.	With the preceding.
Toxonidea. Donkin.	
,, Gregoriana. Donkin	Ireland's Eye, co. Dublin.
,, insignis. Donkin,	Malahide, co. Dublin.
Triceratium. Ehr.	
,, alternans. Bailey,	Mud of R. Liffey, Dublin Bay.
,, amblyoceros. Ehr.	Stomachs of oysters. Poolbeg, co. Dublin.
,, exiguum. Wm. Sm.	R. Liffey, co. Dublin.
Tryblionella. Wm. Sm.	
,, scutellum. Wm. Sm.	Murrough, near town of Wicklow.
,, gracilis. Wm. Sm.	Newcastle, co. Wicklow.
,, marginata. Wm. Sm.	Portmarnock, co. Dublin.
,, punctata. Wm. Sm.	Malahide, Portmarnock, co. Dublin. Newcastle, co. Wicklow.
,, acuminata. Wm. Sm.	Howth, Malahide, Portmarnock, co. Dublin. Salt ditch near town of Wicklow.
,, angustata. Wm. Sm.	Friarstown, R. Dodder, co. Dublin.
,, apiculata. Greg.	Monkstown, Howth, co. Dublin.
,, constricta. Greg.	Monkstown, co. Dublin. Salt ditch near town of Wicklow.
,, lævidensis. Wm. Sm.	Malahide, co. Dublin. Newcastle, co. Wicklow.
,, Hantzschiana. Grunow.	Newcastle, co. Wicklow.
,, Neptuni. Schuman,	Howth, co. Dublin.

THE LICHENS OF THE COUNTIES OF DUBLIN AND WICKLOW.

BY

GREENWOOD PIM, M.A., F.L.S.

[Read March 18, 1878.]

The annexed list of Lichens is compiled chiefly from the catalogue given by Dr. Taylor in the Flora Hibernica and that by Admiral Jones, published in the proceedings of the Dublin Natural History Society. This was submitted to the well-known Lichenologist, Mr. Isaac Carroll, of Cork, who has added a very large number of species, many of which have been detected since the time of Admiral Jones. Mr. Carroll believes that there are at least 140 species of lichens in Dublin and Wicklow still unrecorded, inasmuch as those in the Flora of County Cork amount to about 290, while those of this district hitherto collected only number 150.

The compiler wishes to take this opportunity of expressing his thanks to Mr. Carroll for his invaluable assistance in making out the following list, which doubtless would have been more perfect had Mr. Carroll explored this region as thoroughly as he has examined Cork and Kerry.

Family. COLLEMACEI.

Tribe. Lichinei.

Genus. Ephebe. Fr.	
pubescens. Fr.	Dublin Mts. W. Archer.
Genus. Lichina. Ag.	
pygmæa. Ag.	Dublin. D. Moore.
confinis. Ag.	Dublin. D. Moore.

Tribe. Collemei.

Genus. Collema. Ach.	
pulposum. Ach.	Probably frequent. I.C.
var. tenax. Ach.	Taylor in Flor. Hib. Near Dublin.
=C. limosum.	Mr. Carroll believes that the true C. limosum Ach. is not Irish.
nigrescens. L.	Dargle. Flor. Hib.

Genus. Leptogium. Ach.	
fragrans. Ach.	Dargle. Flor. Hib. Mr. Carroll is doubtful about this form.
tremelloides. Ach.	Dargle. Whitley Stokes.
palmatum. Nyl.	Luggelaw. Crombie. Jones.
muscicola. Nyl.	Luggelaw. Jones.
Family. LICHENACEI.	
Tribe. Calicei.	
Genus. Calicium. Pers.	
sphærocephalum. Ach. (= trachelinum. Ach).	Powerscourt. Dr. Stokes.
Tribe. Sphærophorei.	
Genus. Sphærophoron. Pers.	
coralloides. P.	Rocks. Common.
Tribe. Stereocaulei.	
Genus. Stereocaulon. Schreb.	paschale. Ach. var. denudatum. Luggelaw. Lough Bray. Jones.
Tribe. Cladoniei.	
Genus. Pycnothelia. Ach.	
papillaria. Duf.	Howth. Jones.
Genus. Cladonia. Hffm.	
cervicornis. Schær.	Lough Bray. Jones.
pyxidata. Fr.	Abundant.
fimbriata. Hffm.	Common.
gracilis. Hffm.	Kilranelagh. Jones.
cornuta. Fr.	Dargle. G. Pim.
degenerans. Flk. var. anomala. Ach.	Kelly's glen. D. Moore.
furcata. Hffm.	Common. Dargle. G. P.
cornucopioides. Fr.	Frequent.
deformis. Hffm.	Howth. D. Moore.
digitata. Hffm.	Kelly's glen. D. Moore.
macilenta. Hffm.	Powerscourt. G. Pim.
var. carcata. Ach.	Killiney. D. Moore.
bellidiflora. Schær.	Kelly's glen. D. Moore.
rangiferina. Hffm.	Heaths and commons.
uncialis. Hffm.	Do. Do.
Tribe. Usneei.	
Genus. Usnea. Hffm.	
barbata. Fr.	On trees and rocks, common and variable. Powerscourt, &c.

Tribe. Ramalinei.

Genus. Alectoria. Ach.	
jubata. Ach.	Lough Bray and Killiney. Flor. Hib. Luggelaw. Jones.
Genus. Evernia. Ach.	
furfuracea. Mann.	Lough Bray. Flor. Hib. Rochestown Hill. Herb. T.C.D.
prunastri. L.	Powerscourt. Ovoca. Common.
Genus. Ramalina. Ach.	
scopulorum. Ach.	Rocks by the sea frequent. Howth.
calicaris. Fr.	var. canaliculata. Fr. Trees. I.C.
	var. fraxinea. Fr. Common. I.C.
	var. farinacea. L. Do. I.C.
	var. fastigiata. L. Do. I.C.

Tribe. Cetrariei.

Genus. Cetraria. Ach.	
aculeata. Fr.	Heaths. I.C.
Genus. Platysma. Hffm.	
glaucum. L.	Luggelaw. Jones.

Tribe. Peltigerei.

Genus. Nephromium. Nyl.	
lævigatum. Ach.	Luggelaw. Jones.
lusitanicum. Schaer.	Do.
Genus. Peltigera: Hffm.	
canina. L.	Very common.
rufescens. Hffm.	Frequent.

Tribe. Parmeliei.

Genus. Stictina. Nyl.	
fuliginosa. Dicks.	Old trees.
sylvatica. L.	Powerscourt. G. P.
Genus. Ricasolia. De Not.	
herbacea. Huds.	Powerscourt. D. Moore.
Genus. Parmelia. Ach.	
caperata. L.	Rocks, &c. Common.
olivacea. L.	Rocks and trees. Frequent.
prolixa. Ach.	Howth. D. Moore.
physodes. L.	Powerscourt. G. S. Gough.
perlata. L.	Trees, rocks. Common.
var. ciliata. D.C	Rocks.
Borreri. Turn.	Near Wicklow. Dr. Maingay.
conspersa. Ehr.	Killiney. Jones.
saxatilis. L.	Rocks and trees. Common.
var. furfuracea. Schær.	Lough Bray. Flor. Hib.
lævigata. Sm.	Mountain rocks.
incurva. Pers.	Rare. Howth. D. Moore.

Genus. Physcia. Nyl.	
flavicans. Sw.	Dublin Mts. and Killiney. Flor. Hib. Lambay. I.C.
parietina. L.	Trees and walls. Very common.
lychnea. Ach.	Luggelaw. Jones.
pulverulenta. Schreb.	Trees. Not rare. I.C.
obscura. Ehr.	"Trees near Grand Canal at Lyons, probably frequent." I.C.
stellaris. L.	Trees. Frequent.
var. tenella.	Ditto.
erosa. Borr.	Very rare. Dargle. Flor. Hib.
aquila. Ach.	Maritime rocks.
Genus. Umbilicaria, Hffm.	
pustulata. Hffm.	Lough Dan. Jones.
polyphylla. L.	Luggelaw. Jones.
erosa. Web.	Ditto. Ditto.
polyrhiza. L.	Tonelagee. Flor. Hib.
proboscidea. Ach.	
var fimbriata. T. and B.	Glenmaher. I.C.
Tribe. Lecanorei.	
Genus. Pannaria. Delis.	
carnosa. Dicks.	
var. determinata. Nyl.	Dublin. Mts. and Luggelaw. Jones.
Genus. Amphiloma. Fr.	
lanuginosum. Ach.	Shady rocks and banks. I.C.
Genus. Squamaria. D.C.	
crassa. Huds.	Skerries. D. Moore.
Genus. Placodium, D.C.	
murorum. Hffm.	Rocks, &c., common.
citrinum Ach.	Walls. Frequent.
Genus. Lecanora, Ach.	
pruinosa. Sm.	Granite rocks near Dublin. Flor. Hib.
tartarea. L.	Rocks. I.C.
parella. L.	Rocks and trees.
rupestris. Scop.	Rocks, &c.
var. calva Dicks.	Limestone.
varia. Ehr.	Trees and rocks.
atra. Huds.	Rocks, especially near the coast; also trees. I.C.
cinerea. L.	Rocks.
sulphurea. Hffm.	Killiney. Jones.
subfusca. L.	Rocks and trees. Common.
var. coilocarpa.	Lambay. I.C.
calcarea. L.	Limestone.

var. Hoffmanni. Ach.	Near Portmarnock and Feltrim Hill. Fl. Hib.
aurantiaca. Light.	Trees and rocks. Very variable.
cerina. Ehr.	Trees. Not rare. I. C.
sophodes Ach.	Trees and rocks. Frequent.
var exigua. Ach.	Portmarnock. Fl. Hib.
atrocinerea. Dicks.	Luggelaw. Jones.
erysibe. Ach.	Near Dublin. Taylor.
ventosa. L.	Near Dublin. Stokes. A submerged form. Luggelaw. Jones.
Genus. Urceolaria Ach.	
scruposa. L.	Portmarnock. Fl. Hib. Glendalough. Jones.
Genus. Pertusaria. D.C.	
Westringii. Ach.	Lough Bray. Turner.
ceuthocarpa. Sm.	Lough Bray. Turner and Borrer.
communis. D.C.	Trees, &c.
fallax. P.	Ditto.
ferruginea. L.	Ditto.
pustulata. Ach.	Ditto.
Genus. Thelotrema. Ach.	
lepadinum. Ach.	Trees in mountainous districts.

Tribe. Lecideei.

Genus. Lecidea. Ach.	
atro-rufa. Dicks.	Djouce. Jones.
lurida. Sw.	Glasnevin. D. Moore.
decolorans. Flk.	Co. Wicklow. D. Moore. Lough Bray. Jones.
vernalis. Ach.	Lough Dan. Jones.
sanguinaria. L.	Lough Bray. Templeton. Jones.
parasema. Ach.	Trees. Common. Bray. G.P.
uliginosa. Schrad.	Dublin Mts. Lough Bray. Jones.
tessellata. Flk.	Lough Bray. Jones.
tenebrosa. Flot.	Killiney. Lough Bray. Luggelaw. Jones.
polycarpa. Flk.	Killiney. D. Moore.
var. declinans Nyl.	
rivulosa. Ach.	Mountain rocks. Lugnaquilla. I.C.
contigua. Fr.	Rocks. Common.
gelatinosa. Flk.	Kelly's Glen. D. Moore.
canescens. Dicks.	Co. Wicklow. D. Moore. Usually barren.
disciformis. Fr.	Rocks and trees. Howth and Killiney. Jones.
atro-alba. Ach.	Rocks. Not rare. I.C.
badio-atra. Flk.	Killiney. Jones.

	vesicularis. Hffm.	North wall. Brown. Sand hills, Baldoyle. Fl. Hib.
	pineti. Schrad.	Baltinglass. I.C.
	lutea. Dicks.	Luggelaw. Jones.
	albo-atra. Hffm. (= L. speirea. Fl. Hib.)	Portmarnock.
	melæna. Nyl.	Howth. Jones.
	milliaria. Fr.	Frequent.
	var. montana. Nyl.	Co. Wicklow. D. Moore.
	citrinella. Ach.	Turf. Co. Wicklow. D. Moore.
	muscorum. Sw.	Malahide. Carrington.
	geographica L.	Mountain rocks. Sugarloaf, &c.
	petræa. Wulf.	Rocks frequent.
	concentrica. Dav.	Rocks, &c., common.
	parmeliarium. Smrf.	Roundwood. Jones.
	cladoniaria. Nyl.	Kelly's Glen. D. Moore.
Genus.	Graphis. Ach.	
	scripta. Ach.	Trees. Frequent.
Genus.	Opegrapha. Ach.	
	atra. Pers.	Trees. Common.
	varia. Pers.	Trees. Common.
	vulgata. Ach.	Trees. Frequent.
Genus.	Stigmatidium. Mey.	
	crassum. Dub.	Old trees.
Genus.	Arthonia. Ach.	
	cinnabarina. Wallr.	Trees.
	astroidea. Ach. var Swartziana.	Trees. Common. I.C.
	varians. Dav.	parasitic on Lecanora subfusca. Lambay. I.C.

Tribe. Pyrenocarpei.

Genus.	Endocarpon. Hedw.	
	miniatum. L.	Rocks.
	fluviatile. D.C.	Dargle. Stokes. Luggelaw. Jones.
Genus.	Verrucaria. Pers.	
	mucosa. Whlnb.	Howth. D. Moore.
	epigaea. Pers.	Killiney. Taylor.
	margacea. Whlnb.	Wet rocks.
	maura. Whlnb.	Maritime rocks.
	viridula. Schrad.	Limestone.
	rupestris. Schrad.	Rocks, &c.
	var. muralis. Ach.	Near Dublin. D. Moore.
	calciseda. D. C.	Limestone.
	gemmata. Ach.	Trees. Frequent.
	epidermidis. Ach.	Trees. Common variable.

	lectissima. Fr.	Dargle. Fl. Hib.
	var. irrigua. Tayl.	
	calcaricola. Mudd.	Killiney. Jones.
	nitida. Schrad.	Trees.
	nigrescens. Pers.	Dublin. Jones.
	umbrina ?	Dargle. Fl. Hib.
Genus.	Endococcus. Nyl.	
	erraticus. Mass.	Killiney. Jones.

THE FUNGI OF THE COUNTIES OF DUBLIN AND WICKLOW.

By GREENWOOD PIM, M.A., F.L.S.

[Read March 18, 1878.]

In presenting the accompanying list of Fungi of Dublin and Wicklow, the compiler wishes to point out that it cannot be considered as embodying all, or nearly all, the species to be found in the district. The reason of this is not far to seek. With the exception of a short list of some fifty species, published by Wade in his "Plantae Rariores in Hibernia inventae" in 1804, the only available materials are the observations made by the writer in leisure hours during the past five years. Hence it is evident that but little can be said as to the rarity or otherwise of the species, except as regards a few forms which occur with sufficient frequency to be considered common. Doubtless, as investigation proceeds, many kinds now only recorded from one or two localities will be found elsewhere, and many new ones added to the list.

Almost nothing is known as yet of the Mycology of Ireland; and it is highly desirable that observers in all parts of the country should work vigorously at this, the only department of our Flora which has escaped the attention of Botanists.

To any one conversant with Fungi, the paucity (and in some instances absence in the subjoined list) of the species of some orders will seem remarkable. Such are Hypogaei, Sphæronemei, Tuberacei, Sphæriacei, &c. This is due, no doubt, to the minuteness of many of the species, and the subterranean habits of others, rendering them less likely to be observed as compared with the larger and more showy forms.

So far, about 470 species have been met with in the district, which is probably two-thirds of those actually to be expected.

The arrangement adopted by Dr. Cooke in his "Handbook" has been followed in this list. In all cases where no authority is quoted, and in many where there is, the writer is responsible for the identification of the species: the persons named being those by whom the specimens were communicated.

DIVISION I.—SPORIFERA.

FAMILY I.—HYMENOMYCETES.

Order.—Agaricini. Fries.
Genus.—Agaricus. Linn.

Subgenus. Amanita. Pers.		
	vaginatus. Bull.	Fassaroe, near Bray.
	ceciliæ. B. and Br.	Dargle.
	mappa. Batsch.	Powerscourt.
	muscarius. L.	Scalp. Ovoca.
	rubescens. P.	Powerscourt. Scalp. Ovoca.
Subgenus. Lepiota. Fries.		
	procerus. Scop.	Mount Merrion.
	delicatus. Fr.	Powerscourt. Rev. M. J. Berkeley.
	holosericeus. Fr.	Powerscourt.
	cristatus. Fr.	Lawns and meadows; everywhere abundant.
Subgenus. Armillaria. Fr.		
	ramentaceus. Bull.	Powerscourt.
	melleus. Vahl.	Stumps, abundant. Powerscourt. Fassaroe. Ovoca, &c.
	mucidus. Fr.	Powerscourt; on a beech tree.
Subgenus. Tricholoma. Fr.		
	flavo-brunneus. Fr.	Hollybrook, near Bray; abundant.
	rutilans. Schæf.	Scalp, woods.
	scalpturatus. Fr.	Shankill. Dargle.
	luridus. Schæf.	Powerscourt.
	imbricatus. Fr.	Fassaroe.
	murinaceus. Bull.	Hollybrook.
	terreus. Schæf.	Hollybrook. Mount Merrion, abundant.
	lascivus. Fr.	Ovoca.
	gambosus. Fr.	Near Bray; in various localities, common.
	monstrosus. Sow.	Ovoca.
	albus. Fr.	Powerscourt.
	personatus. Fr.	Howth. Dr. W. M. A. Wright. Mount Merrion. G.P.
	grammopodius. Bull.	Monkstown. Dargle.
	humilis. Fr.	Shankill. Powerscourt.
	subpulverulentus. P.	Hazlehatch, Co. Dublin.
	melaleucus. P.	Fassaroe.
Subgenus. Clitocybe. Fr.		
	nebularis. Batsch.	Kilbride, near Bray. Shankill.
	inornatus. Sow.	Fassaroe.

cerussatus. Fr.	Hollybrook. Powerscourt, abundant.
candicans. Fr.	Scalp.
gallinaceus. Scop.	Foxrock.
infundibuliformis. Schæf.	Devil's Glen.
geotrupus. Bull.	Hollybrook.
cyathiformis. Fr.	Shankill.
brumalis. Fr.	Scalp.
fragrans. Sow.	Near Carrickmines. Hollybrook. Ovoca, common.
laccatus. Scop.	Ovoca. Mount Merrion, and elsewhere, common.
Subgenus. Pleurotus. Fr.	
ulmarius. Bull.	College Park, on poplar; very large, pileus, 12 in. by 9 in.
craspedius. Fr.	Dunran, Co. Wicklow.
mitis. P.	Mount Merrion.
Subgenus. Collybia. Fr.	
radicatus. Relh.	Monkstown, apparently not very common.
platyphyllus. Fr.	Killakee.
fusipes. Bull.	Powerscourt. Brackenstown—Wade, Plant. rar.
velutipes. Curt.	Near Kilternan. Glendruid, &c.
confluens. P.	Hollybrook.
acervatus. Fr.	Bray. Glasnevin.
collinus. Scop.	Powerscourt.
clavus. Bull.	Santry. Wade, Plant. ran.
dryophilus. Bull.	Powerscourt. Hollybrook. Fassaroe.
tenacellus. P.	Glendruid.
Subgenus. Mycena. Fr.	
purus. P.	In woods, common. Ovoca, &c.
iris. Berk.	Bray.
lacteus. P.	Shankill. Mount Merrion.
galericulatus. Scop.	Woods, common.
alcalinus. Fr.	Mount Merrion, &c.
epipterygius. Scop.	Dargle. Kilbride, near Bray.
vulgaris. P.	Bray.
tenerrimus. Berk.	Monkstown, common.
Subgenus. Omphalia. Fr.	
pyxidatus. Bull.	Powerscourt, common.
muralis. Sow.	Charleville. Near Bray. Dargle.
umbelliferus. L.	Carrickmines.
fibula. Bull.	Easton Lodge, Monkstown.
Subgenus. Volvaria. Fr.	
parvulus. Weinm.	Powerscourt.
speciosus. Fr.	Shankill.
Subgenus. Chamæota. Sm.	
cretaceus. Fr.	Glasnevin. Wade, Plant. rar.

Subgenus.	Pluteus. Fr.	
	cervinus. Schæff.	Hollybrook. [I am not certain of this species.]
Subgenus.	Entoloma. Fr.	
	nidorosus. Fr.	Shankill.
Subgenus.	Leptonia. Fr.	
	lampropus. Fr.	Powerscourt.
Subgenus.	Nolanea. Fr.	
	pascuus. P.	Dalkey. Dr. W. M. A. Wright.
	rufo-carneus. Bk.	Kilbride, near Bray. Ovoca, common.
Subgenus.	Eccilia. Fr.	
	carneo-griseus. B. & Br.	Devil's Glen. A doubtful form.
Subgenus.	Pholiota. Fr.	
	aureus. Math.	Dargle.
	squarrosus. Mull.	On stumps; very common. Fassaroe. Powerscourt, &c.
	adiposus. Fr.	Scalp.
	mutabilis. Schæf.	Killakee.
Subgenus.	Hebeloma. Fr.	
	testaceus. Batsch.	Fassaroe.
	fastigiatus. Fr.	Mount Merrion.
	scaber. Müll.	Glasnevin. Wade, Plant rar.
	fibrosus. Sow.	Scalp.
	Curreyi. Bk.	Powerscourt.
	geophyllus. Sow.	Near Delgany.
	crustuliniformis. Bull.	Powerscourt.
	rimosus. Bull.	Hollybrook. Ovoca, common.
Subgenus.	Flammula. Fr.	
	lentus. P.	Scalp.
	flavidus. Schæf.	Powerscourt.
Subgenus.	Naucoria. Fr.	
	sideroides. Bull.	Kilbride.
	pediades. Fr.	Dalkey. Dr. W. M. A. Wright.
	melinoides. Fr.	In grass, common.
	semiorbicularis. Bull.	Dargle.
	furfuraceus. P.	On orchid-pot, Rockville, Blackrock.
Subgenus.	Galera. Fr.	
	tener. Schæf.	Dalkey. Dr. W. M. A. Wright.
	hypnorum. Batsch.	Dargle, &c., common.
Subgenus.	Psalliota. Fr.	
	arvensis. Schæf.	Powerscourt, &c. Not nearly so common as P. campestris.
	campestris. L.	Pastures, &c., very abundant.
	vaporararius. Otto.	
	sylvaticus. Schæf.	Kilbride. Hollybrook. Scalp.
Subgenus.	Stropharia. Fr.	
	semiglobatus. Batsch.	Common.
	æruginosus. Curt.	Scalp. Dr. W. M. A. Wright.

Subgenus. Hypholoma. Fr.		
	sublateritius. Fr.	Scalp.
	fascicularis. Hud.	On stumps; extremely common everywhere. Perhaps our commonest agaric.
	dispersus. Fr.	Scalp.
	velutinus. P.	Charleville. Bray, abundant.
	appendiculatus. Bull.	
	egenulus. Berk.	Powerscourt. [I am not certain of this species.]
Subgenus. Psilocybe. Fr.		
	areolatus. Klotch.	Fassaroe.
	spadiceus. Schæf.	Common.
	Fœnisecii. P.	Do.
Subgenus. Panæolus. Fr.		
	campanulatus. L.	Santry. Wade.
	separatus. L.	Dr. W. M. A. Wright.
	fimiputris. Bull.	Common.
	papilionaceus. Bull.	Monkstown.
Subgenus. Psathyrella. Fr.		
	gracilis. Fr.	Kilmacanoge, near Bray.
Genus. Coprinus. Fr.		
	comatus. Fr.	Pastures, roads, &c., common.
	atramentarius. Fr.	College Park, &c., abundant.
	micaceus. Fr.	Extremely common everywhere.
	niveus. Fr.	Dung, &c.
	radiatus. Fr.	Common.
	domesticus. Fr.	Easton Lodge, Monkstown.
	plicatilis. Fr.	Charleville.
	hemerobius. Fr.	Do.
Genus. Bolbitius. Fr.		
	tener. B.	Charleville. Bray.
Genus. Cortinarius. Fr.		
	(Phlegmacium) varius Fr.	Scalp.
	purpurascens. Fr.	Hollybrook.
	(Dermocybe) sanguineus. Fr.	Ovoca, not common.
	(Hygrocybe) armeniacus. Fr.	Scalp. Powerscourt.
Genus. Lepista. Sm.		
	personata. Fr.	Powerscourt, abundant.
Genus. Paxillus. Fr.		
	involutus. Fr.	Shankill, Powerscourt, &c., frequent.
	panuoides. Fr.	On oak; Powerscourt.
Genus. Hygrophorus. Fr.		
	pratensis. Fr.	Meadows and pastures plentiful.
	virgineus. Fr.	Bray Head, &c.
	niveus. Fr.	Monkstown.

	ceraceus. Fr.	Ovoca?
	coccineus. Fr.	Fassaroe.
	miniatus. Fr.	Carrickmines.
	puniceus. Fr.	Bray.
	conicus. Fr.	Fassaroe.
	psittacinus. Fr.	Pastures, common.
	murinaceus. Fr.	Powerscourt.
Genus.	Gomphidius. Fr.	
	glutinosus. Fr.	Powerscourt.
Genus.	Lactarius. Fr.	
	insulsus. Fr.	Dargle. Ovoca.
	blennius. Fr.	Hollybrook. Ovoca, common.
	pyrogalus. Fr.	Kilbride. Bray.
	piperatus. Fr.	Powerscourt. Ovoca.
	vellereus. Fr.	Powerscourt.
	deliciosus. Fr.	Fassaroe, &c., common.
	volemum. Fr.	Ovoca.
Genus.	Russula. Fr.	
	nigricans. Fr.	Ovoca. Hollybrook, &c.
	delica. Fr.	Ovoca.
	virescens. Fr.	Ovoca.
	foetens. Fr.	Hollybrook. Kilbride. Ovoca, &c.
	emetica. Fr.	Hollybrook. Ovoca.
	alutacea. Fr.	In woods, abundant.
Genus.	Cantharellus. Adams.	
	cibarius. Fr.	Ovoca, &c. common.
	retirugus. Fr.	On moss. Loughlinstown. Dargle.
Genus.	Nyctalis. Fr.	
	parasitica. Fr.	On Russulæ. Ovoca.
Genus.	Marasmius. Fr.	
	urens. Fr.	Scalp. Fassaroe.
	peronatus. Fr.	Scalp.
	oreades. Fr.	Pastures, common. Howth. Dundrum. Wicklow, &c.
	Wynnei. B and Br.	
	terginus. Fr.	Hollybrook.
	impudicus. Fr.	Fassaroe.
	Vaillantii. Fr.	Dalkey. Dr. W. M. A. Wright.
	rotula. Fr.	Dargle.
	graminum. B. and Br.	Near Bray.
	insititius. Fr.	Ovoca.
	androsaceus. Fr.	Ovoca.
	Hudsoni. Fr.	Hollybrook.

Order—Polyporei.

Genus.	Boletus. Fr.	
	luteus. L.	Powerscourt.
	bovinus. L.	Brackenstown. Wade, Pl. Rar.
	elegans. Schum.	Scalp.

	flavus. With.	Ovoca.
	laricinus. B.	Shankill.
	badius. Fr.	Bray.
	chrysenteron. Fr.	Shankill.
	subtomentosus. L.	Ovoca. Scalp.
	satanas. Lenz.	Dalkey. Dr. W. M. A. Wright.
	luridus. Fr.	Powerscourt. Glasnevin. A. G. More.
	edulis. Bull.	Powerscourt.
	olivaceus. Schæf.	Brackenstown. Wade.
	scaber. Fr.	Shankill. Powerscourt.
	pachypus. Fr.	Ovoca. Powerscourt.
Genus. Polyporus. Fr.		
	lentus. Berk.	On furze. Near Bray, in several localities.
	squamosus. Fr.	On trunks, very common.
	sulfureus. Fr.	Hollybrook. Powerscourt.
	cytisinus. Bk.	Glasnevin. Wade.
	fumosus. Fr.	Common.
	hispidus. Fr.	Powerscourt.
	dryadeus. Fr.	Hollybrook. Cherry Valley.
	fomentarius. Fr.	Delgany. Hollybrook.
	igniarius. Fr.	Common.
	radiatus. Fr.	Hollybrook.
	velutinus. Fr.	Do.
	versicolor. Fr.	Extremely common, and variable.
	abietinus. Fr.	Powerscourt.
	armeniacus. Bull.	Ovoca.
	ferruginosus. Fr.	Ashford.
	vaporarius. Fr.	Common in woods.
Genus. Dædalea. Fr.		
	quercina. P.	Powerscourt.
Genus. Merulius.		
	corium. Fr.	Hollybrook.
	lacrymans. Fr.	Common.
Genus. Fistulina.		
	hepatica. Fr.	Phœnix Park. Wade, plant. rar.

Order—Hydnei.

Genus. Hydnum. Linn.		
	repandum. L.	Powerscourt. Ovoca.
	ochraceum. P.	Glendruid.
Genus. Radulum. Fr.		
	quercinum. Fr.	Delgany. Ovoca.

Order—Auricularini.

Genus. Craterellus. Fr.		
	cornucopioides. Fr.	Ovoca.
	sinuosus. Fr.	Ovoca.
Genus. Thelephora. Fr.		

		cæsia. P.	Scalp.
		mollissima. P.	Scalp.
Genus.	Stereum. Fr.		
		purpureum. Fr.	Cherry Valley.
		hirsutum. Fr.	On stumps, very common.
Genus.	Hymenochæte. Lev.		
		rubiginosa. Lev.	Ovoca.
Genus.	Corticium. Fr.		
		sulfureum. Fr.	Dargle.
		quercinum. P.	Devil's Glen.
		comedens. Fr.	Hollybrook.
		cinereum. Fr.	Bray.
		nudum. Fr.	Mount Merrion.
Genus.	Cyphella. Fr.		
		griseo-pallida. Fr.	Ovoca.
		capula. Fr.	Kilbride (Yellow var.).
		Goldbachii. Fr.	Monkstown.

Order—Clavariei.

Genus.	Clavaria. L.		
		coralloides. L.	Powerscourt. Stillorgan.
		cinerea. Bull.	Powerscourt.
		cristata. Holmsk.	Glendruid.
		rugosa. Bull.	Bray.
		abietina. Schum.	Ovoca.
		purpurea. Müll.	Powerscourt.
		inæqualis. Müll.	Do.
		vermiculata. Scop.	Ovoca.
		juncea. Fr.	Dargle.
		uncialis. Grev.	Powerscourt.
Genus.	Calocera. Fr.		
		viscosa. Fr.	Hollybrook.
Genus.	Pistillaria. Fr.		
		quisquilaris. Fr.	Glasnevin.
		furcata. Sm.	Monkstown.

Order—Tremellini.

Genus.	Tremella. Fr.		
		mesenterica. Retz.	Easton Lodge. Powerscourt. Dargle, common.
		albida. Hud.	Dargle, &c., common.
Genus.	Exidia.		
		recisa. Fr.	Powerscourt.
Genus.	Hirneola. Fr.		
		auricula-Judæ. Bk.	Mount Merrion. Blackrock. Newtown Mount-Kennedy, &c., frequent.
Genus.	Dacrymyces. Nees.		
		deliquescens. Dub.	Monkstown.
		stillatus. Nees.	On pine wood, very common.

Family II.—Gasteromycetes.

Order—Phalloidei.

Genus. Phallus. L.

impudicus.	L.	Scalp. Powerscourt. Hollybrook. Widely distributed, but nowhere common.

Order—Trichogastres.

Genus. Geaster. Mich.

fimbriatus.	Fr.	Monkstown.
rufescens.	Fr.	Do.

Genus. Bovista. Dill.

nigrescens.	P.	Powerscourt.

Genus. Lycoperdon. Tourn.

cælatum.	Fr.	Common.
giganteum.	Batsch.	Powerscourt.
saccatum.	Vahl.	Do.
geminatum.	Fr.	Hollybrook. Scalp.
pyriforme.	Schæf.	Powerscourt. Mount Merrion.

Genus. Scleroderma. P.

vulgare.	Fr.	Powerscourt, &c. Ovoca, &c.
bovista.	Fr.	Glendruid. Miss Finlay.

Order—Myxogastres.

Genus. Lycogala. Mich.

epidendrum.	Fr.	Loughlinstown.

Genus. Reticularia. Bull.

applanata.	B. and Br.	Bray.
umbrina.	Fr.	Monkstown.

Genus. Æthalium. Link.

vaporarium.	Fr.	On tan. Monkstown.

Genus. Diderma. P.

vernicosum.	P.	Scalp.
lucidum.	B. and Br.	Monkstown.
globosum.	Fr.	Scalp.

Genus. Didymium. Schrad.

farinaceum.	Fr.	Powerscourt.
xanthopus.	Fr.	Howth.

Genus. Physarum.

nutans.	P. var aureum.	Scalp.
bulbiforme.	Schum.	Powerscourt.

Genus. Stemonitis. Gled.

ovata.	P.	Powerscourt.
fusca.	Roth.	Glasnevin. Wade.

Genus. Arcyria. Hill.

punicea.	P.	Ovoca.
incarnata.	P.	Powerscourt, very abundant.

Genus. Trichia. Hall.
turbinata. With. Hollybrook. Powerscourt, abundant.
Genus. Licea. Schrad.
cylindrica. Fr. Howth.

Order—Nidulariacei.
Genus. Cyathus. P.
striatus. Hfm. Glasnevin. Dr. Moore.
vernicosus. D.C. Dublin. G. S. Eves. Bellevue. Near Delgany. Wade.
Genus. Sphærobolus. Tode.
stellatus. Tode. Mount Merrion.

FAMILY III.—CONIOMYCETES.

Order—Sphæronemei.
Genus. Phoma. Fr.
asteriscus. Bull. On dead stems. Common.
Genus. Diplodia. Fr.
herbarum. Lev. On Fennel.
Genus. Vermicularia. Tode.
dematium. Fr. Enniskerry.
Genus. Piggotia. B. and Br.
gladioli. Pim. Decaying gladiolus leaves. Monkstown. 1876.
Genus. Dinemasporium. Lev.
graminum. Lev. var. herbarum. Cooke. On dead stem. Killiney.
Genus. Asteroma. D.C.
rosæ. D.C. Monkstown. Bray, &c. Very common.

Order—Melanconiei.
Genus. Glœosporium. Mont.
fructigenum. B. On Apples. Very common.

Order—Torulacei.
Genus. Torula. Pers.
ovalispora. Bk. Dargle.
pulveracea. Ca. Seapoint.
herbarum. Lk. Dead stems. Monkstown.
Genus. Septonema. Ca.
irregulare. B. and Br. Dargle.
Genus. Sporochisma. B. and Br.
mirabile. B. and Br. On holly twigs. Hollybrook.
Genus. Sporidesmium. Link.
lepraria. B. and Br. Decaying gladiolus. Monkstown.

Order.—Pucciniæi.

Genus. Phragmidium. Lk.		
	mucronatum. Link.	On wild and garden roses, very common.
	bulbosum. Schl.	On bramble leaves, extremely common.
Genus. Triphragmium. Link.		
	ulmariae. Link.	Ballybrack.
Genus. Puccinia. Pers.		
	graminis. Pers.	Corn and grass leaves. Common.
	arundinacea. Hedw.	Ballybrack.
	striola. Link.	Hollybrook.
	primulæ. Grev.	Devil's Glen.
	menthae. Pers.	Ballybrack.
	compositarum. Sch.	
	glomerata. Grev.	Ballybrack.
	variabilis. Grev.	Ballybrack, Rocky Valley.
	apii. Corda.	Received from Mr. T. Moore. Locality not stated.
	saniculae. Grev.	Dargle, Ovoca. Common.
	smyrnii. Corda.	Carrickmines, Kill-o'-Grange, Glendruid, Newcastle. Abundant; one of our commonest species.
	violarum. Link.	Monkstown.
	umbilici. Guep.	Enniskerry, Stepaside. Abundant.
	epilobii. D.C.	Ballybrack.
	prunorum. Link.	Dalkey. Dr. W. M. A. Wright.
	malvacearum.	On hollyhocks and wild mallow. In many localities. Very common since 1874.
Genus. Gymnosporangium. D.C.		
	juniperi. Lk.	Powerscourt.
Genus. Podisoma. Lk.		
	sabinae. Fr.	Blackrock. Rev. M. H. Close.

Order.—Cæomacei.

Genus. Ustilago. Link.		
	carbo. Tul.	Oats, &c., common.
	grandis. Tul.	Ballybrack.
Genus. Coleosporium. Lev.		
	tussilaginis. Lev.	Coltsfoot. Very common.
	pingue. Lev.	Garden and wild roses. Common; chiefly affects the wild ones.
	petasitis. Lev.	On Butterbur.
	sonchi-arvensis. Lev.	Bray.
	rhinanthacearum. Lev.	Near Fassaroe.
Genus. Melampsora. Cast.		
	salicina. Lev.	Dargle. Plentiful.

	populina. Lev.	Fassaroe.
	euphorbiae. Cast.	Very common wherever the Spurge occurs.
Genus. Cystopus. DeBary.		
	candidus. Lev.	On Cabbage, very common.
	cubicus. Str.	Monkstown.
Genus. Uredo. Lev.		
	hypericorum. D.C.	Dargle.
Genus. Trichobasis. Lev.		
	petroselini. B.	Abundant. The *uredo* form of Puccinia smyrnii.
	oblongata. B.	Glendruid.
	suaveolens. Lev.	On thistles. Very common.
	compositarum. var. hieracii. Ck.	Kilmacanoge, Ovoca.
	rumicum. Cooke.	Killiney.

Order.—Æcidiacei.

Genus. Æcidium. Pers.		
	epilobii. D.C.	Ballybrack. Common.
	ranunculacearum. D.C.	Ballybrack.
	grossulariæ. D.G.	Gooseberry leaves and fruit. Plentiful.
	urticæ. D.C.	Templeogue, Co. Dublin. Apparently not common.
	compositarum. Mart. var. tussilaginis. Pers.	Extremely common. Usually followed by *Coleosporium tussilaginis*. Lev. Qu. A condition ?
	var. bellidis. D.C.	Ovoca.
	saniculæ. Carm.	Very abundant wherever Sanicula, which is common in the district, grows.

FAMILY IV. HYPHOMYCETES.

Order.—Isariacei.

Genus. Ceratium. A. and S.		
	hydnoides. A. and S.	Hollybrook.
Genus. Pachnocybe. Bk.		
	subulata. B. ?	Monkstown. Along with Dactylium.

Order.—Stilbacei.

Genus. Volutella. Fr.		
	ciliata. Fr.	On decaying Gladiolus.
	setosa. Bk.	On decaying Gladiolus.
	phaii. Pim.	On decaying leaves of Phaius grandifolius.

Genus. Epicoccum Link.
neglectum. Desm. On decaying maize. Monkstown.
Genus. Ægerita. P.
candida. P. Common.

Order—Dematiei.
Genus. Sporocybe. Fr.
byssoides. Fr. On orchid bulb.
Genus. Haplographium. B. and Br.
delicatum. B and Br. Monkstown, Ovoca.
Genus. Helminthosporium Link.
velutinum. Lk. Monkstown.
Genus. Macrosporium. Fr.
cheiranthi. Fr. Monkstown.
Genus. Polythrincium. Kunze.
trifolii. Kze. Monkstown.
Genus. Cladosporium. Link.
herbarum. Lk. Common.
epiphyllum. Nees. Monkstown.
bacilligerum. Mont. Monkstown. On rose leaves.
nodulosum, Ca. Decaying onion.

Order—Mucedines.
Genus. Aspergillus. Mich.
glaucus. Lk. Very common.
Genus. Rhinotrichum. Corda.
repens. Preuss. Monkstown.
Genus. Botrytis. Mich.
tilletii. Desm. On Begonia.
dichotoma. Corda. Monkstown. This I believe is the only occasion of this species occurring in Britain.
Genus. Peronospora DeBary.
infestans. Mont. Often very common.
gangliformis. Berk. Monkstown. On lettuce.
parasitica. Pers. Monkstown. On wallflower and cabbages.
effusa. Casp. On spinach. Monkstown.
candida. Fckl. Monkstown. On primrose.
Genus. Haplaria. Link.
grisea. Lk. On Paxillus. Hollybrook.
Genus. Polyactis. Link.
vulgaris. Lk.
cana. Berk. Monkstown.
cinerea. Berk.
Genus. Penicillium. Link.
crustaceum. Fr. Extremely common.
bicolor. Fr. On condensed milk.
candidum Lk. var coremium. On dead leaves.

Genus. Dactylium. Nees.		
	pyriferum. Fr.	Monkstown, &c. Common.
	macrosporum. Fr.	On moss. Ovoca.
Genus. Cylindrium. Bon.		
	septatum Bon.	On gladiolus.
Genus. Fusidium. Link.		
	flavo-virens. Fr.	Hollybrook.
Genus. Helicomyces.		
	roseus.	Fassaroe.
Genus. Sporotrichum. Link.		
	sulphureum. Grev.	Scalp.
Genus. Menispora. Pers.		
	lucida. Ca.	On Tacsonia.
Genus. Acremonium. Link.		
	verticillatum. Link.	On vine. Monkstown.
	fuscum, Sch.	On Hoya. Blackrock.
Genus. Botryosporium. Ca.		
	pulchrum. Ca.	Monkstown.
Genus. Rhopalomyces. Ca.		
	pallidus B. and Br.	On tan.
	candidus B. and Br.	On pods of Nice pepper.

Order—Sepedoniei.

Genus. Sepedonium. Link.		
	chrysospermum. Lk.	On Boleti. Common. Scalp, Ovoca.
	roseum. Fr.	Dunran.

DIVISION II.—SPORIDIIFERA.

FAMILY V. PHYSOMYCETES.

Order.—Antennariei.

Genus. Zasmidium. Fr.		
	cellare. Fr.	In cellars, very common.

Order.—Mucorini.

Genus. Mucor. Mich.		
	ramosus. Bull. Var. α.	On Strelitzia. Var. β. On Heracleum.
	mucedo. L.	On fruits, &c. Extremely common.
	caninus. S.	On dogs' dung. Common.
	clavatus. Lk.	On plums.
Genus. Hydrophora. Tode.		
	stercorea. Tode.	On seedling pots.
Genus. Acrostalagmus. Corda.		
	cinnabarinus. Ca.	On decaying potatoes.

FAMILY VI. ASCOMYCETES.

Order.—Perisporiacei.	
Genus.—Sphærotheca. Lev.	
pannosa. Lev.	On roses; the conidioid condition; extremely common. I have only once found conceptacles.
Castagnei. Lev.	Monkstown. Newcastle, County Wicklow. Common.
Genus. Phyllactinia. Lev.	
guttata. Lev.	Dalkey. Local. Where it occurs abundant.
Genus. Uncinula. Lev.	
adunca. Lev.	Carrickmines.
bicornis. Lev.	Common. Monkstown. Ballybrack.
Wallrothii. Lev.	Carrickmines and elsewhere.
Genus. Podosphæra. Kunze.	
clandestina. Lev.	Carrickmines. Near Bray, &c. Not uncommon.
Genus. Microsphæria. Lev.	
berberidis. Lev.	Kingstown. Glasnevin.
grossulariae. Lev.	On gooseberry. Abundant.
Genus. Erysiphe. Hedw.	
graminis. D. C.	Widely diffused, but not very common.
martii. Lk.	Peas, &c. Very common.
communis. Schl.	On columbine, Circæa, &c. Common.
Genus. Eurotium. Lk.	
Herbariorum. Lk.	On a tan-bed. Extremely abundant.
Order. Elvellacei.	
Genus. Morchella. Dill.	
esculenta. P.	Glasnevin. Wade.
Genus. Helvella. Linn.	
crispa. Fr.	Luttrellstown. Wade. Hollybrook. G. P.
Genus. Mitrula. Fr.	
cucullata. Fr.	Glencullen. A. G. More.
paludosa. Fr.	Above Powerscourt Waterfall. Glencullen.
Genus. Spathularia. P.	
flavida. P.	Shankill. Abundant.
Genus. Leotia. Hill.	
lubrica. P.	Ovoca. Kilbride.
Genus. Geoglossum. P.	
viride. P.	Hollybrook.

olivaceum. P.	Hollybrook.
glabrum. P.	Glencullen. Abundant. Also Kilternan.
Genus. Peziza. Linn.	
(Aleuria. Fr.) acetabulum. L.	Dargle. Common.
badia. P.	Powerscourt.
leporina. Batsch.	Powerscourt.
onotica. P.	Howth.
cerea. Sow.	Glasnevin. Wade.
vesiculosa. Bull.	Dunghills. Very common.
cupularis. L.	Monkstown.
saniosa. Schrad.	Charleville.
granulata. Bull.	Cow-dung. Common.
(Lachnea. Fr.)	
scutellata. L.	Hollybrook.
stercorea. P.	Bray.
ciliaris. Schrad.	Powerscourt.
virginea. Batsch.	Monkstown. Ovoca.
calycina. Schum.	Altidore.
clandestina. Bull.	Monkstown.
variecolor. Fr.	Altidore. Dunran.
villosa. P.	Enniskerry.
(Phialea. Fr.)	
firma. P.	Glencullen.
striata. F.	Fassaroe.
caucus. Reb.	Ovoca.
vinosa. A. & S.	Tullow, County Dublin.
cinerea. Batsch.	Powerscourt. Common.
vulgaris. Fr.	Dargle.
var. β. diaphana.	Hollybrook.
leucostigma. Fr.	Monkstown.
Genus. Helotium.	
æruginosum. Fr.	Powerscourt. Ovoca, with fine cups.
citrinum. Fr.	Ovoca, &c. Common.
epiphyllum. Fr.	Altidore.
fagineum. Fr.	Hollybrook.
Genus. Ascobolus. Tode.	
Crouani. Cooke.	Monkstown.
furfuraceus. P.	Cow-dung. Common.
Genus. Phacidium. Fr.	
coronatum. Fr.	Devil's Glen.
Genus. Rhytisma. Fr.	
acerinum. Fr.	Very common.
Genus. Hysterium. Tode.	
fraxini. P.	Powerscourt, and elsewhere. Common.
hederæ. De Not.	Common.
arundinaceum. Schrad.	Common.

Genus.	Stegia. Fr.	
	ilicis. Fr.	Common.
Genus.	Trochila. Fr.	
	lauro-cerasi. Fr.	Devil's Glen.

Order. Sphæriacei.

Genus.	Nectria. Fr.	
	cinnabarina. Fr.	Extremely common.
	aquifolia. Berk.	Blackrock. Rev. M. H. Close.
	peziza. Fr.	Glasnevin.
	sanguinea. Fr.	Hollybrook.
Genus.	Xylaria. Fr.	
	hypoxylon. Grev.	Extremely common.
Genus.	Hypoxylon. Fr.	
	fuscum. Fr.	Hollybrook, &c.
Genus.	Eutypa. Tul.	
	lata. Tul.	Hollybrook.
Genus.	Dothidea. Fr.	
	ulmi. Fr.	Monkstown.
	filicina. Fr.	On bracken, Powerscourt.
Genus.	Diatrype. Fr.	
	disciformis. Fr.	Hollybrook.
Genus.	Valsa. Fr.	
	nivea. Fr.	Monkstown. Spermogonia only.
Genus.	Cucurbitaria. Gray.	
	laburni. De Not.	On laburnum. Common.
Genus.	Sphæria. Hall.	
	tristis. Tode.	Dargle.
	macrotricha. B. & Br.	Glasnevin.
	moriformis. Tode.	Altidore.
	botryosa. Fr.	Altidore.
	ordinata. Fr.	Shankill.
	pulviscula. Curr.	Glasnevin.
	pulvis-pyrius. P.	Monkstown.
	arundinacea. Sow.	Ballybrack.
	culmifraga. Fr.	Dalkey.
	acuta. Moug.	Monkstown.
	setacea. P. Var. petiolae.	Glendruid.
Genus.	Capnodium. Mont.	
	sphæricum. Cooke.	Dargle. On Veronica.

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ROYAL DUBLIN SOCIETY.

HUNDRED AND FORTY-NINTH SESSION, 1879–80.

MINUTES OF PROCEEDINGS.

MONDAY EVENING, NOVEMBER 17TH, 1879.

Sections I. and III.—Physical and Experimental Science, and Applied Science.

(With which the "Dublin Scientific Club" is associated.)

W. F. BARRETT, F.R.S.E., in the Chair.

The following Communications were laid before the Section:—

G. F. FITZGERALD, F.T.C.D.—"On the possibility of originating Wave Disturbances in the Ether by means of Electric Forces."

(Transactions, Vol. I., Part X.)

R. J. MOSS, F.C.S.—"Note on some points in the Analyses of Commercial Superphosphates."

G. JOHNSTONE STONEY, D.SC., F.R.S.—"Report on the Progress of Science—Professor Henry Newton's Researches on Cometary Astronomy."

The following were exhibited:—

Photographs of the Sun. (Presented to the Society by M. Janssen.)

Photograph of a portion of the Solar Spectrum, illustrating Prof. Draper's discovery of Oxygen in the Sun. (Presented to the Society by W. Erck, LL.D.)

Section II.—Natural Science.

(With which the "Royal Geological Society of Ireland" is associated.)

Rev. Dr. HAUGHTON, F.R.S., in the Chair.

The following Communications were laid before the Section:—

G. ORMONDE STONEY, Captain 25th Regiment.—"On supposed Footprints on the Surface of a Rock near Mulrany, Co. Mayo."

Professor HULL, LL.D., F.R.S.—"Relation of the Carboniferous and Devonian Formations of the South of Ireland with those of North Devon."

(Transactions, Vol. I., Part XI.)

W. R. M'NAB, M.D.—"Note on the Root Hairs of *Azolla pinnata.*"

W. R. M'NAB, M.D.—"On Branched Hairs from the Stamen of *Tradescantia Virginica.*"

W. R. M'NAB, M.D.—"On some Abnormal Flowers of Primula."
(Proceedings, Vol. II., N.S.)

MONDAY EVENING, DECEMBER 15TH, 1879.

Sections I. and III.—Physical and Experimental Science, and Applied Science.

(With which the "Dublin Scientific Club" is associated.)

G. JOHNSTONE STONEY, D.SC., F.R.S., in the Chair.

The following Communications were laid before the Section:—

Professor W. NOEL HARTLEY, F.R.S.E., F.C.S.—"On the Relation of Chemical Structure to certain Optical Properties of Organic Substances."

HOWARD GRUBB, M.E., F.R.A.S—"On the New Astronomical Observatory, Cork."
(Proceedings, Vol. II., N.S).

JOHN R. WIGHAM—Exhibited the Albo-Carbon method for improving the illuminating power of Gas."

Section II.—Natural Science.

(With which the "Royal Geological Society of Ireland" is associated.)

Rev. MAXWELL H. CLOSE, M.A., in the Chair.

The following Communications were laid before the Section:—

V. BALL, M.A., F.G.S.—"On Spheroidal Jointing in Metamorphic Rocks in India and elsewhere, producing forms resembling *roches Moutonneés.*
(Proceedings, Vol. II., N.S.)

Rev. Dr. HAUGHTON, F.R.S.—"A comparison of the July and January Temperatures of Grinnell Land and Spitzbergen at present and in Miocene times, with an attempt to show that the Gulf Stream influences both."

PERCY EVANS FREKE.—"A Comparative Catalogue of the Birds found in Europe and North America."
(Proceedings, Vol. II., N.S.)

Monday Evening, January 19th, 1880.

Section I.—Physical and Experimental Science.

(With which the "Dublin Scientific Club" is associated.)

Howard Grubb, m.e., f.r.a.s., in the Chair.

The following Communications were laid before the Section:—

G. F. Fitzgerald, f.t.c.d.—"Note on the Conductivity of Tourmaline."

G. F. Fitzgerald, f.t.c.d.—"Note on the Construction of absolute Electrometers."

(Proceedings, Vol. II., N.S.)

Professor J. Emerson Reynolds, m.d.—Short Reports from the Chemical Laboratory of Trinity College:

No. 8.—"On the production of Specular Deposits of Lead Sulphide."

No. 9.—"On the Desulphuration of Thiocarbonide."

Professor W. F. Barrett, f.r.s.e.—"On Edison's Loud-speaking Telephone, and the Theory of its Action."

Section II.—Natural Science.

(With which the "Royal Geological Society of Ireland" is associated.)

G. Johnstone Stoney, d.sc., f.r.s., in the Chair.

The following Communications were laid before the Section:—

Rev. Dr. Haughton, f.r.s.—"On an Application of Prof. Rossetti's newly-discovered Law of Cooling to the question of Radiation of Heat from the Earth, and to problems of Geological Climate and Time."

(Proceedings, Vol. II., N.S.)

Dr. Frazer, f.r.c.s.i.—Exhibited *Bopyrus Squillarum,* parasitic on *Palæmon serratus,* and an Antler of Red Deer, obtained from the Dodder Bar in the River Liffey.

Monday Evening, February 16th, 1880.

Section I.—Physical and Experimental Science.

(With which the "Dublin Scientific Club" is associated.)

Wentworth Erck, ll.d., in the Chair.

The following Communications were laid before the Section:—

Charles E. Burton, b.a., f.r.a.s.—"Physical Observations of Mars, 1879-80."

(Transactions, Vol. II., Part XII.)

Prof. W. F. BARRETT, F.R.S.E.—Notes from the Physical Laboratory of the Royal College of Science :

No. 1.—"On the cause of the vibration in the Trevelyan Rocker."

No. 2.—"On the effect of Temperature on the Illuminating Power of Coal Gas."

G. JOHNSTONE STONEY, D.SC., F.R.S.—"On a New Harmonic Relation between the Lines of Hydrogen."

Report on the Progress of Science.—Dr. J. STONEY, F.R.S.—"On Dr. Huggin's discovery of a Group of Spectral Lines characteristic of White Stars."

Section II.—Natural Science.

(With which the "Royal Geological Society of Ireland" is associated.)

G. H. KINAHAN, M.R.I.A., President Royal Geological Society of Ireland, in the Chair.

The following Communications were laid before the Section:—

"Anniversary Address by the President of the Royal Geological Society of Ireland (1880.)"

(Proceedings, Vol. II., N.S.)

V. BALL, M.A., F.G.S.—"On the evidence in favour of the existence of Floating Ice in India, during the deposition of the Talchir (Permian) Rocks."

(Proceedings. Vol. II., N.S.)

MONDAY EVENING, MARCH 15TH, 1880.

Sections I. and III.—Physical and Experimental Science, and Applied Science.

(With which the "Dublin Scientific Club" is associated.)

Professor BARRETT, F.R.S.E., in the Chair.

The following Communications were laid before the Section:—

J. L. E. DREYER, M.A., F.R.A.S.—"A Record of the Progress of Astronomy during the year 1879."

(Proceedings, Vol. II., N.S.)

G. JOHNSTONE STONEY, D.SC., F.R.S.—"Note on Maxwell's Theory of Stresses in Rarified Gases."

G. JOHNSTONE STONEY, D.SC., F.R.S.—"A simple Formula for the volume of Gas produced by a chemical reaction."

S. HUNTER, F.R.A.S.—"On the absence of the Lunar Atmosphere, the origin of Saturn's Nebulary Ring, and the Zodiacal Light."

ARTHUR E. PORTE—Exhibited a Telephone Exchange at work.

Section II.—Natural Science.

(With which the "Royal Geological Society of Ireland" is associated.)

Rev. Dr. Haughton in the Chair.

The following Communications were laid before the Section:—

"On the question of Suicide among Bees." Being the subject of two Letters from John Luby, Esq., LL.D., to Rev. Professor Haughton, M.D., F.R.S., F.T.C.D.
(Proceedings, Vol. II., N.S.)

A. B. Wynne, F.G.S.—"Notes on some points in the Physical Geology of the Dingle and Iveragh Promontories."
(Proceedings, Vol. II., N.S.)

Monday Evening, April 19th, 1880.

Section I.—Physical and Experimental Science.

(With which the "Dublin Scientific Club" is associated.)

J. Emerson Reynolds, M.D., in the Chair.

The following Communications were laid before the Section:—

G. Johnstone Stoney, D.SC., F.R.S.—"On a possible Cosmical Cause for the Gap in the series of Atomic Weights."

G. Johnstone Stoney, D.SC., F.R.S.—"Report on the Progress of Science—Lord Rayleigh's Investigations on the Theory of the Spectroscope."

G. Johnstone Stoney, D.SC., F.R.S.—"A Direct Vision Spectroscope."

Captain Abney's Photograph of the Spectrum exhibiting the Natural Colours was exhibited.

Wentworth Erck, LL.D., F.R.A.S.—Exhibited a new Form of constant Bichromate Battery.

S. Yeates—Exhibited Noë's Thermo-Electric Battery, and an "Aladin" Lamp.

Section II.—Natural Science.

(With which the "Royal Geological Society of Ireland" is associated.)

Rev. M. H. Close, M.A., in the Chair.

The following Communications were laid before the Section:—

Thomas Plunkett, Esq.—"On a Trap-dyke in Poll-a-Phuca Mountain, Co. Fermanagh."

W. Williams, Esq.—"Changes of Climate as indicated by the Lacustrine Deposits of Ireland."

W. R. M'Nab, M.D.—Exhibited Models of Insectivorous Plants, and Engler's Diagram Apparatus for Illustrating the Structure of Flowers.

Wednesday Evening, May 19th, 1880.

(*Instead of the third Monday of the Month, which on this occasion fell on Whit-Monday*).

Section I.—Physical and Experimental Science.

(With which the "Dublin Scientific Club" is associated.)

Charles Cameron, M.D., in the Chair.

The following Communications were laid before the Section:—

Professor J. Emerson Reynolds, M.D.—"On a New Process for Coating Metallic and other surfaces with reflecting layers of Galene."

G. F. Fitzgerald, F.T.C.D.—"Note on Fluorescence."
(Proceedings, Vol. II., N.S.)

G. F. Fitzgerald, F.T.C.D.—"On the possibility of originating Wave Disturbances in the Ether by means of Electric Forces." (No. 2).
(Transactions, Vol. III., Part XIII.)

G. F. Fitzgerald, F.T.C.D.—Report on the Progress of Science—Prof. Minchin's Investigations in Phototelegraphy.

Section II.—Natural Science.

(With which the "Royal Geological Society of Ireland" is associated).

William Ramsay M'Nab, M.D., in the Chair.

The following Communications were laid before the Section:—

Richard M. Barrington, LL.B.—"On the Introduction of the Squirrel into Ireland."
(Proceedings, Vol. II., N.S.)

V. Ball, M.A., F.G.S.—"On the Occurrence of Gold in India, with special reference to the recent discoveries of it in the Madras Presidency."
(Proceedings, Vol. II., N.S.)

E. T. Hardman, F.C.S.—"On a Nickleiferous Serpentine from Sligo, containing a large quantity of Magnetite."

E. T. Hardman, F.C.S.—"On a Travertine from Co. Sligo, containing a considerable amount of Strontia."
(Proceedings, Vol. III., N.S., Part I.)

E. T. Hardman, F.C.S.—Exhibited part of the Skull and other bones of a Pre-historic Man, discovered in a Kist-vaen at Coolaney, near Sligo, with associated Food-urn; also a second Urn found near the same place.

Monday Evening, June 21st, 1880.

Section I.—Physical and Experimental Science.

(With which the "Dublin Scientific Club" is associated.)

R. C. R. Tichborne, ph.d., f.c.s., in the Chair.

The following Communications were laid before the Section :—

Howard Grubb, m.e., f.r.a.s.—"On a new Simple Form of Equatorial Telescope for Students' Use."

C. A. Cameron, m.d.—"On the action of Water on Mercuric Sulphate." (Proceedings, Vol. II., N.S.)

H. N. Draper, f.c.s.—"On the influence of Albumen on the Crystallization of Nitrate of Urea."

J. Emerson Reynolds, m.d., f.r.s.—Exhibited Meyer's Vapour Density Apparatus, and Dr. Dupré's Mode of Testing Wine for foreign colouring matter.

Section II.—Natural Science.

(With which the "Royal Geological Society of Ireland" is associated).

Edward Hull, ll.d., f.r.s., in the Chair.

The following Communications were laid before the Section :—

V. Ball, m.a., f.g.s.—"On the mode of Occurrence and Distribution of Diamonds in India."

(Proceedings, Vol. II., N.S.)

Thomas Plunkett, m.r.i.a.—"On Chert in the Limestone of Knockbeg, Co. Fermanagh.

(Proceedings, Vol. II., N.S.)

ROYAL DUBLIN SOCIETY.

HUNDRED AND FIFTIETH SESSION, 1880–81.

MINUTES OF PROCEEDINGS.

MONDAY EVENING, NOVEMBER 15TH, 1880.

Sections I. and II.—Physical and Experimental Science, and Applied Science.

With which the "Dublin Scientific Club" is associated.

WENTWORTH ERCK, LL.D., F.R.A.S., in the Chair.

The following Communications were laid before the Section:—

C. E. BURTON, B.A., F.R.A.S., and HOWARD GRUBB, M.E., F.R.A.S.—"A New Form of Ghost Micrometer for Astronomical Instruments."
(Proceedings, Vol. III., N.S., Part I.)

WILLIAM SMITH, C.E.—"Preliminary Note on the Manufacture of Paper from Purple Melic Grass (*Molinia cœrulea*).
(Proceedings, Vol. III., N.S., Part I.)

G. F. FITZGERALD, F.T.C.D.—"Recent Advances in Physical Science":—

1. Captain Galton's mode of determining the heights and distances of Clouds.
2. Professor Osborne Reynolds's Theory of how Oil stops the propagation of Waves on the surface of Water.

Section III.—Natural Science.

(With which the "Royal Geological Society of Ireland" is associated.

G. H. KINAHAN, President R.G.S.I., in the Chair.

The following Communications were laid before the Section:—

R. J. USSHER and Dr. LEITH ADAMS, F.R.S.—"Explorations in the Bone Cave of Ballynamintra, near Cappagh, Co. Waterford;" with a description of the Physical Features of the vicinity, by G. H. KINAHAN, President, R.G.S.I.
(Transactions, Vol. I., Part XIV., *in press.*)

PERCY E. FREKE.—"North American Birds in Europe."
(Proceedings, Vol. III., N.S., Part I.)

DAVID M'ARDLE.—"Notes on some new and rare Irish Hepaticæ."
(Proceedings, Vol. III., N.S., Part I.)

Fig. 1.

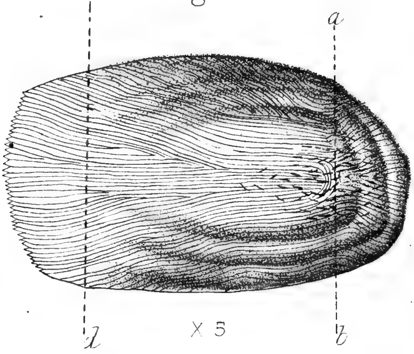


Fig. 2.

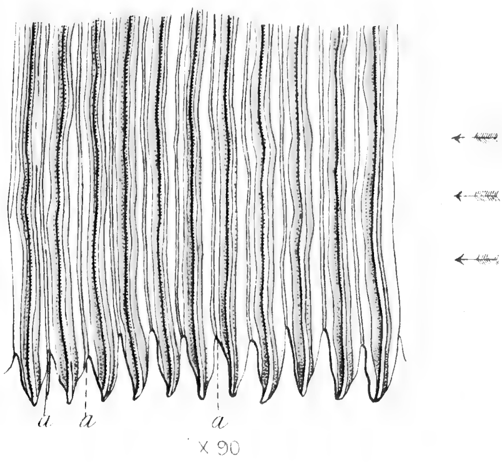
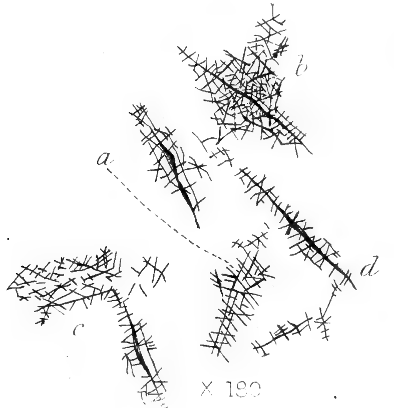


Fig. 3.



H.W.M. ad. nat.

Fig. 4.

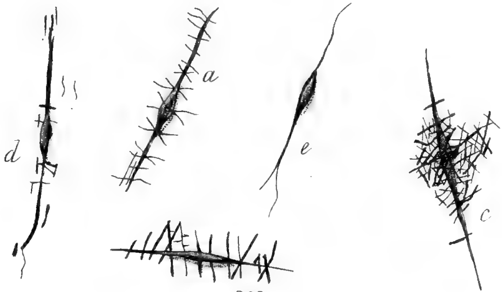


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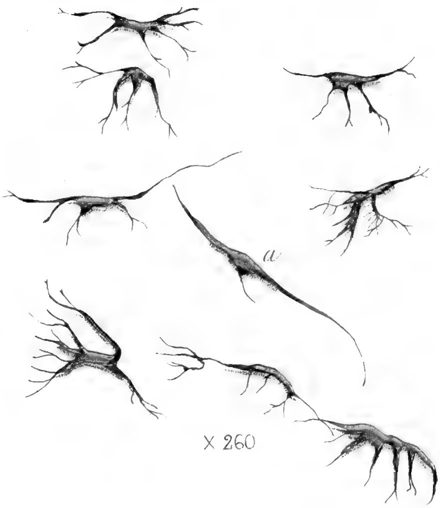
Fig. 5.



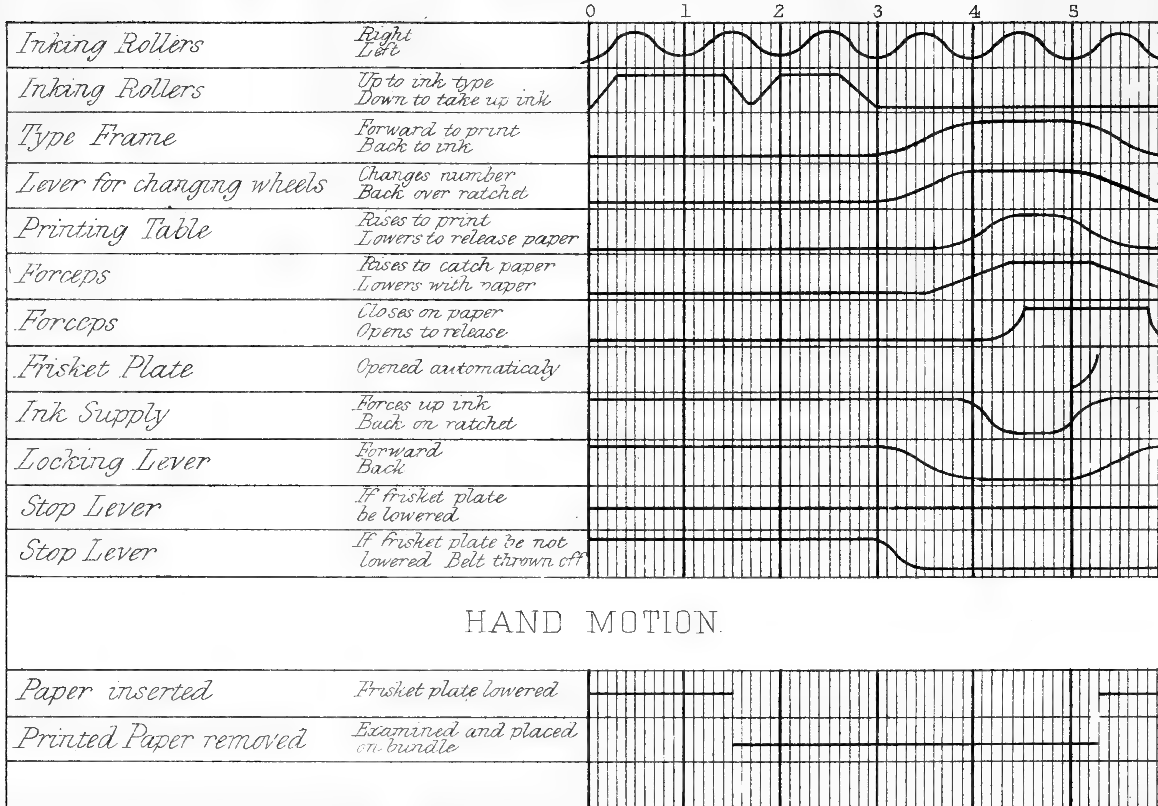
X 260

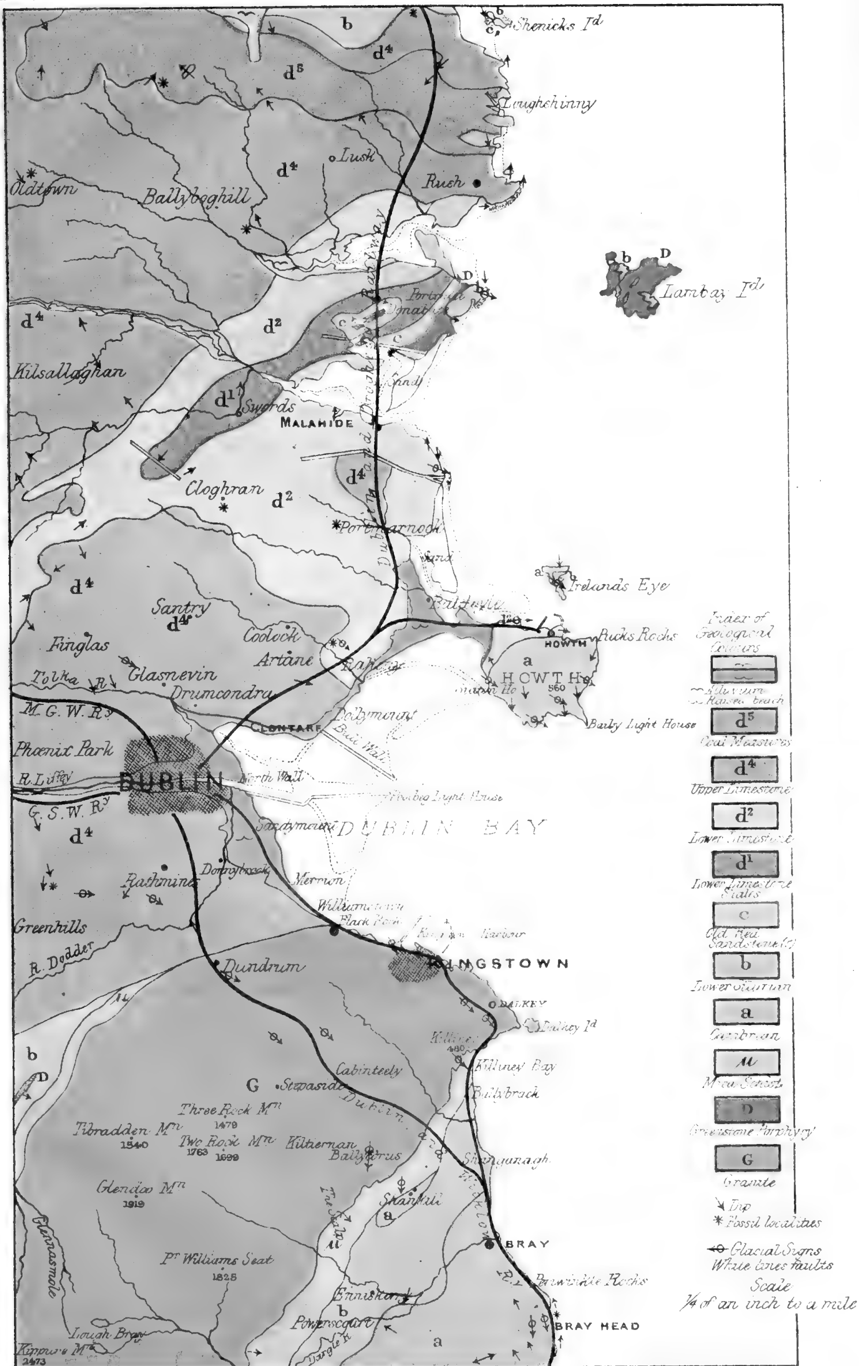
Fig. 6.

X 260

H.W.M. ad nat

AUTOMATIC MOTION.





R. G. Symes, M.A. F.G.S. Forster & Co. Lith. Dublin

Geological Map of the district around DUBLIN reduced from the maps of the Geological Survey of IRELAND.